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November 23, 2004

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Supervisor Zev Yaroslavsky  
Supervisor Michael D. Antonovich

From: David E. Janssen  
Chief Administrative Officer

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**WALT DISNEY CONCERT HALL – GLARE ISSUE**

This is to advise you that we have identified two potential permanent solutions to the glare issues surrounding the Walt Disney Concert Hall Founder's Room. We are currently reviewing the feasibility of the preferred option which can be implemented by June 2005.

**Background**

In June 2003, the Owners Association for the Promenade condominiums notified Walt Disney Concert Hall I, Inc., that the reflection of sunlight off the Concert Hall Founder's Room caused uncomfortable glare levels and temperature increases inside the units on the southeast side of the complex located at the corner of First and Hope Streets.

In July 2003, the County retained Sapphos Environmental, Inc., and their subconsultant, Schiler and Associates (Schiler), to work in cooperation with the project architects, Frank O. Gehry and Associates (FOGA) to identify solutions that reduced glare from certain exterior surfaces of the Founder's Room and the CalArts Theater Marquee to a level that is consistent with those assumed in the Final Environmental Impact Report (EIR) and Addendum No. 2 to the Final EIR prepared by the County in 1999. An initial assessment resulted in a grey mesh fabric being placed over the identified sources of glare and radiant heat as an interim solution.

**Glare Study**

In order to identify options for a permanent solution, Schiler developed a multi-dimensional simulation model of the levels and characteristics of the glare off the

Concert Hall exterior surfaces throughout the year. The model analyzed the data in the context of the three levels of glare that are generally recognized:

- *veiling reflections* which refers to glare that is objectionable primarily because it obscures desired information
- *discomfort glare* which refers to glare that is found objectionable by the viewer but does not cause any physical damage
- *disability glare* which ranges from causing temporary incapacity to permanent eye damage

In addition to the glare reflected to the Promenade, the study analyzed the glare associated with the four intersections proximate to the Concert Hall to determine the presence of reflections that could affect vehicular and pedestrian traffic.

The study concluded that a larger area than identified in the initial assessment of the Concert Hall exterior was producing a discomfort glare sufficient to require resolution. Since the design and implementation of a permanent solution will take up to six months, it was determined that an expanded interim solution was advisable.

The study reviewed whether it was better to increase the amount of grey mesh or apply a film over the selected panels. It was concluded that increasing the grey mesh on the polished exterior panels was the preferred expanded interim solution. This will be implemented immediately.

### **Permanent Solution**

Schiler has identified two different permanent solutions. These two permanent solutions are to brush/sandblast or apply a film to selected surfaces of the Founder's Room and CalArts Theater Marquee. The sandblasting technique was determined to be the preferred option by FOGA.

The County is working with FOGA and Schiler to prepare a plan to implement the recommended permanent solution which would consist of sandblasting selected panels much like the primary finish of the main concert hall. It is anticipated that the sandblasting/brushing will be implemented over a four to six week period and completed by June 2005. To implement the permanent solution, an Addendum to the EIR must be certified by the Board which is tentatively scheduled to be before your Board for approval in January 2005.

Each Supervisor  
November 23, 2004  
Page 3

If you have any questions, please contact me or your staff may contact John Edmisten of my staff at (213) 974-7365.

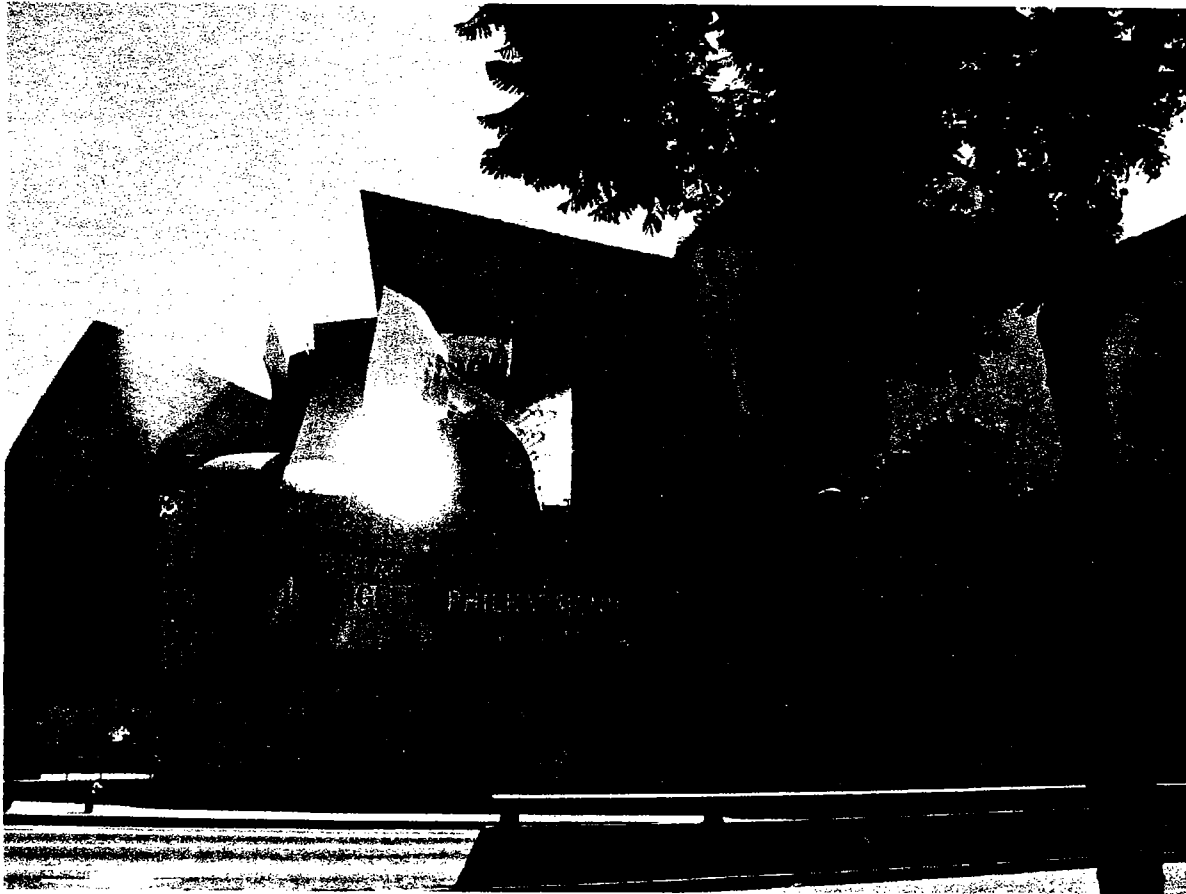
DEJ:JSE  
DKM:i/h

Attachment

c:     Executive Officer, Board of Supervisors  
         County Counsel  
         CalArts Theater  
         Walt Disney Concert Hall I Inc.

Job #03067:

# Disney Hall Glare Study



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# **Final Report**

# **Disney Hall Glare Study**

## Table of Contents

<b>EXECUTIVE SUMMARY .....</b>	<b>1</b>
<b>INTRODUCTION.....</b>	<b>1</b>
A JEWEL .....	1
<b>GLARE ON PROMENADE TOWERS .....</b>	<b>2</b>
VISUAL AND PHOTOGRAPHIC SURVEY .....	3
COMPUTER SURVEYS.....	4
TRANSLATION OF COMPUTER FILES .....	4
MISSING DATA .....	6
SIMULATIONS .....	7
SEASONAL SURVEYS AT HALF-HOUR INTERVALS OF THE FOUNDER’S ROOM .....	7
RESULTS .....	11
SUMMARY .....	12
<b>GLARE AT INTERSECTION OF 1<sup>ST</sup> AND HOPE STREETS .....</b>	<b>13</b>
VISUAL AND PHOTOGRAPHIC SURVEY.....	13
COMPUTER SURVEYS.....	14
SEASONAL SURVEYS AT HALF-HOUR INTERVALS OF THE FOUNDER’S ROOM .....	16
RESULTS .....	19
SUMMARY .....	19
<b>GLARE AT INTERSECTION OF 2<sup>ND</sup> AND HOPE STREETS (CALARTS THEATER MARQUEE) .....</b>	<b>20</b>
VISUAL AND PHOTOGRAPHIC SURVEY.....	20
COMPUTER SURVEYS.....	21
SEASONAL SURVEYS AT HALF-HOUR INTERVALS OF THE FOUNDER’S ROOM .....	21
RESULTS .....	24
<b>GLARE FROM BRUSHED STAINLESS PANELS ON THE HOPE STREET ELEVATION.....</b>	<b>25</b>
SEASONAL SURVEYS AT HOURLY INTERVALS OF THE HOPE STREET ELEVATION.....	25
RESULTS .....	27
<b>GLARE FROM BRUSHED STAINLESS PANELS ON THE 2<sup>ND</sup> STREET ELEVATION .....</b>	<b>27</b>
SEASONAL SURVEYS AT HOURLY INTERVALS OF THE 2 <sup>ND</sup> STREET ELEVATION.....	27
RESULTS .....	28
<b>GLARE AT INTERSECTION OF 1<sup>ST</sup> AND GRAND STREETS.....</b>	<b>28</b>
SEASONAL SURVEYS AT HALF-HOUR INTERVALS OF THE INTERSECTION OF 1 <sup>ST</sup> AND GRAND STREETS.....	29

RESULTS .....	31
<b>GLARE AT INTERSECTION OF 2<sup>ND</sup> AND GRAND STREETS .....</b>	<b>31</b>
SEASONAL SURVEYS AT HALF-HOUR INTERVALS OF THE INTERSECTION OF 2 <sup>ND</sup> AND GRAND STREETS .....	32
RESULTS .....	34
<b>DRIVE-THROUGH FILMING .....</b>	<b>35</b>
KEY FRAMES .....	35
TRAFFIC DENSITY .....	35
RESULTS .....	35
<b>COMPARATIVE DOWNTOWN GLARE .....</b>	<b>35</b>
DOWNTOWN BUILDINGS .....	36
HISTOGRAMS OF DOWNTOWN BUILDINGS .....	40
OTHER REFLECTIVE SOURCES IN THE DOWNTOWN ENVIRONMENT .....	40
RESULTS .....	41
<b>LUMINANCE HISTOGRAMS .....</b>	<b>41</b>
HISTOGRAM OF FOUNDER’S ROOM “EYE” SURFACE .....	44
HISTOGRAM OF HOPE STREET ELEVATION .....	45
HISTOGRAM OF 2ND STREET ELEVATION .....	46
HISTOGRAM OF 1 <sup>ST</sup> AND GRAND STREETS .....	47
HISTOGRAM OF 2 <sup>ND</sup> AND GRAND STREETS .....	48
HISTOGRAM OF 2 <sup>ND</sup> AND HOPE STREETS .....	49
HISTOGRAMS OF OTHER DOWNTOWN BUILDINGS .....	49
SUMMARY .....	49
<b>SOLUTIONS .....</b>	<b>50</b>
COLORLESS TRANSLUCENT FILM .....	50
LIGHT BLUE TRANSLUCENT FILM .....	50
WHITE TRANSLUCENT FILM .....	51
WHITE OPAQUE FILM .....	51
TEST PANEL .....	51
OUTDOOR FABRIC .....	51
SANDBLASTED SURFACE .....	52
<b>TEMPERATURES AT CALARTS THEATER MARQUEE ON SIDEWALK AND STREET .....</b>	<b>52</b>
TEMPERATURE AND RADIANT HEAT .....	52
SUMMER TEMPERATURES .....	56
<b>CONCLUSIONS .....</b>	<b>57</b>

TEMPORARY SOLUTION .....	57
PERMANENT SOLUTION .....	57
FURTHER STUDIES .....	57
<b>SUMMARY .....</b>	<b>57</b>



## **Executive Summary**

The Founder's Room is the primary source of focused glare on adjacent buildings and intersections. Several surfaces or portions of surfaces should be reduced in specularity by brushing, sandblasting, or covering. These are shown in the report. Sandblasting is suggested.

The CalArts Theater Marquee causes localized glare in the intersection and some overheating on surrounding surfaces. More areas on the marquee should be brushed or covered.

There are several sections of the building that become extremely bright, causing diffused heat gain and mild glare. None of the brushed surfaces are sufficiently blinding and/or in line with traffic to be the real cause of any accidents. None of the brushed surfaces cause extreme heat gain in adjacent buildings.

The impact of the Walt Disney Concert Hall on the surrounding environment can be minimized by treating the CalArts Theater Marquee and the Founder's Room surfaces. The result will be a building typical of other large downtown buildings in impact.

## **Introduction**

### **A Jewel**

The Walt Disney Concert Hall (Disney Hall) is designed as an icon for the City of Los Angeles. Frank Gehry, the architect, talks about frozen motion when describing the swooping and complex curved surfaces. The brushed stainless steel, polished stainless steel, and white limestone present a striking, high-impact image for the Los Angeles Philharmonic, City of Los Angeles (City), and County of Los Angeles (County). Indeed, the building is a jewel in many senses. It sparkles in the sun and changes with every different angle of view. In many ways, it is a state-of-the-art building, pushing the envelope of architecture.

Any building that pushes the envelope discovers new difficulties as well as new beauties. The very sparkle that excites the viewer also presents some difficulties. As Jim Hahn, the mayor of Los Angeles, said during the dedication ceremony, "This building has a UV factor of 100" (L.A. Times, 10/21/2003). He was referring to its brightness on the world stage but also to its physical effects on those in its proximity.

There are portions of the building that are especially reflective. The polished stainless steel of the Founder's Room and the CalArts Theater Marquee reflect, and in some cases concentrate, significant amounts of light. This represents the possibility of glare at a distance and even thermal issues on nearby surfaces. Stationary light weight surfaces in the vicinity of the CalArts Theater Marquee can get very hot. There is the possibility of

interference with traffic. The brushed stainless steel panels result in much milder reflections, but are also examined.

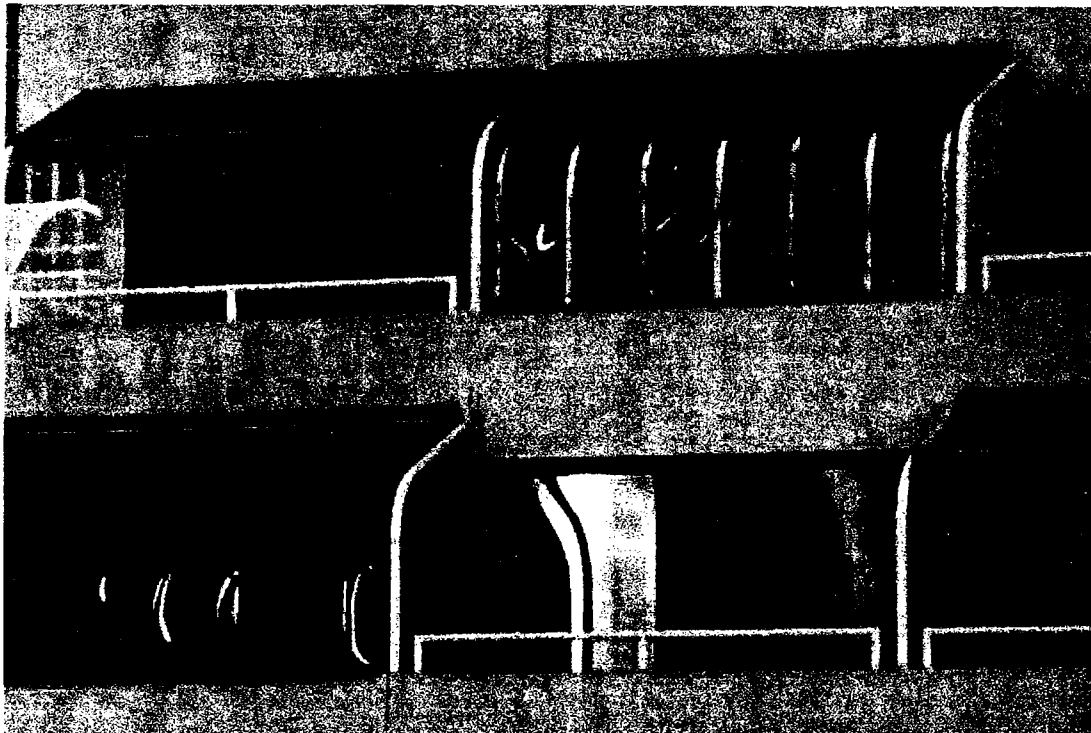
The results of the studies are presented below. For an explanation of the sequence of events during the study, please see the Preliminary Report.

### **Glare on Promenade Towers**

The Founder's Room is located on the north corner of the site. To the northwest, there is a residential mid-rise building, the Promenade Towers. The units of the Promenade Towers that face Disney Hall have a wonderful view. However, there are moments when the sun is reflected directly onto the southeast facade of those units. The lower units are shielded by the terrace and street wall of Disney Hall, but the mid and upper units receive some direct light and some light filtered by trees.

It is useful to note that the southeast facade of the Promenade Towers received direct sunlight before the arrival of the Disney Hall. However, the additional reflected sunlight arrives throughout the afternoon, when the sun has moved to the southwest and west, reflecting off the Founder's Room.

At least one resident of the Promenade Towers has indicated to the County that there are times when they find that the reflections are uncomfortable. This report examines the instances of possible glare, the level of such glare, and what amelioration might prove useful.



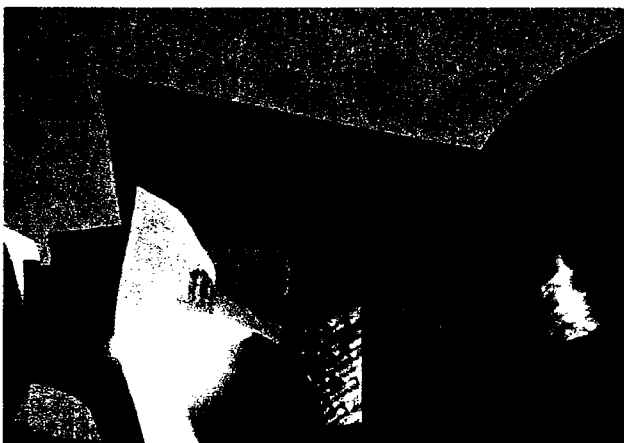
### Visual and Photographic Survey

Several visual and photographic surveys have been made of the building. These found that the “hot spots” and reflections varied significantly throughout the day, often in an unexpected manner. This is especially true of building surfaces that form right angles with one another, producing multiple reflections and some focusing.

Visual surveys of the Founder’s Room found that there is significant light reflection from three surfaces, the “eye” and the two “knees.” There are two large surfaces on the Founder’s Room, which were nicknamed “knees.” They are concave at the top and convex in the lower portions. The upper portions concentrate light but are not large surfaces. The lower portions do not focus light, but unfortunately varying portions of the surface remain bright throughout most afternoons, as the reflection walks down the surface. This means that there is always some reflection towards the units across the street, but less danger of heat gain. The wider portions of these surfaces are lower and are thus filtered by the trees on the patio/terrace.



*Reflective “Eye” on Founder’s Room*



*Reflective “Knee” on Founder’s Room*



*Reflective “Hat” of Brushed Stainless*

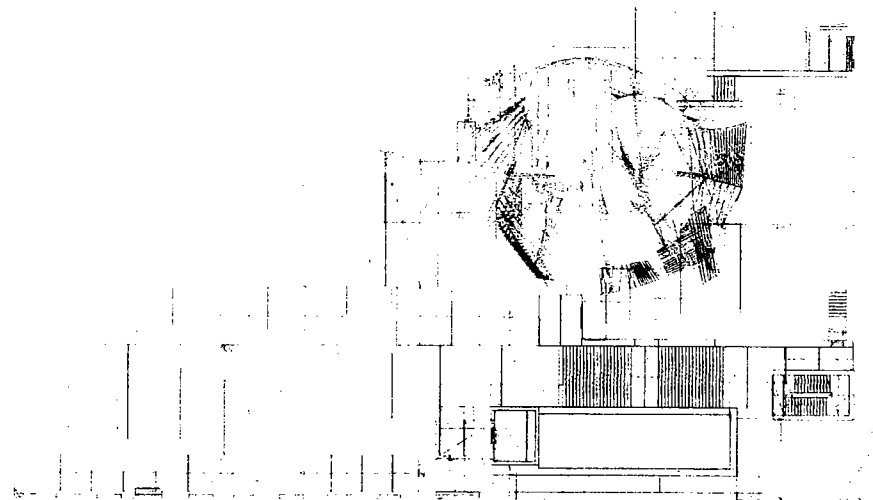
There was also an “eye” that was composed of a surface perpendicular to a concave focusing surface. This produces a collimated beam.

Similarly, there was a portion of the brushed stainless steel facade that posed some possible difficulty. A conic section, halfway down the auditorium facade created some brightness, but no focus.

### Computer Surveys

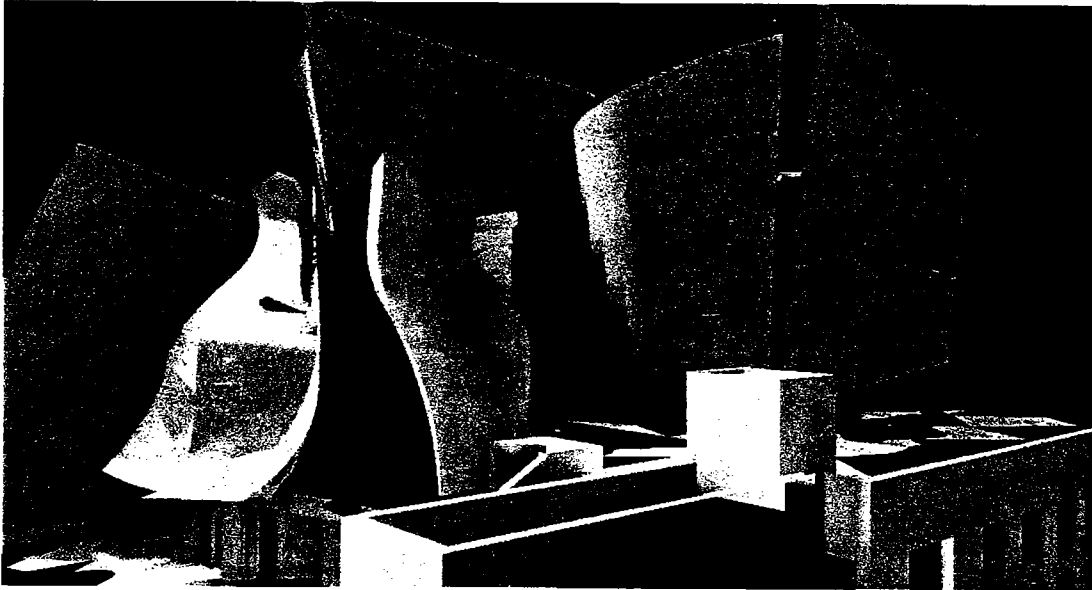
There are two ways of providing a full analysis of the reflections. A complete **physical model** of the building firmly fastened to its base can be tilted and rotated in conjunction with a solar gnomon and then measured and photographed. The photographs can be digitally analyzed for glare. Alternatively, a complete **computer model** can be used in one of several simulation programs, or individual surfaces can be modeled individually.

There were no physical models available for testing. Gehry's office had several computer files available. The computer simulation option was chosen.

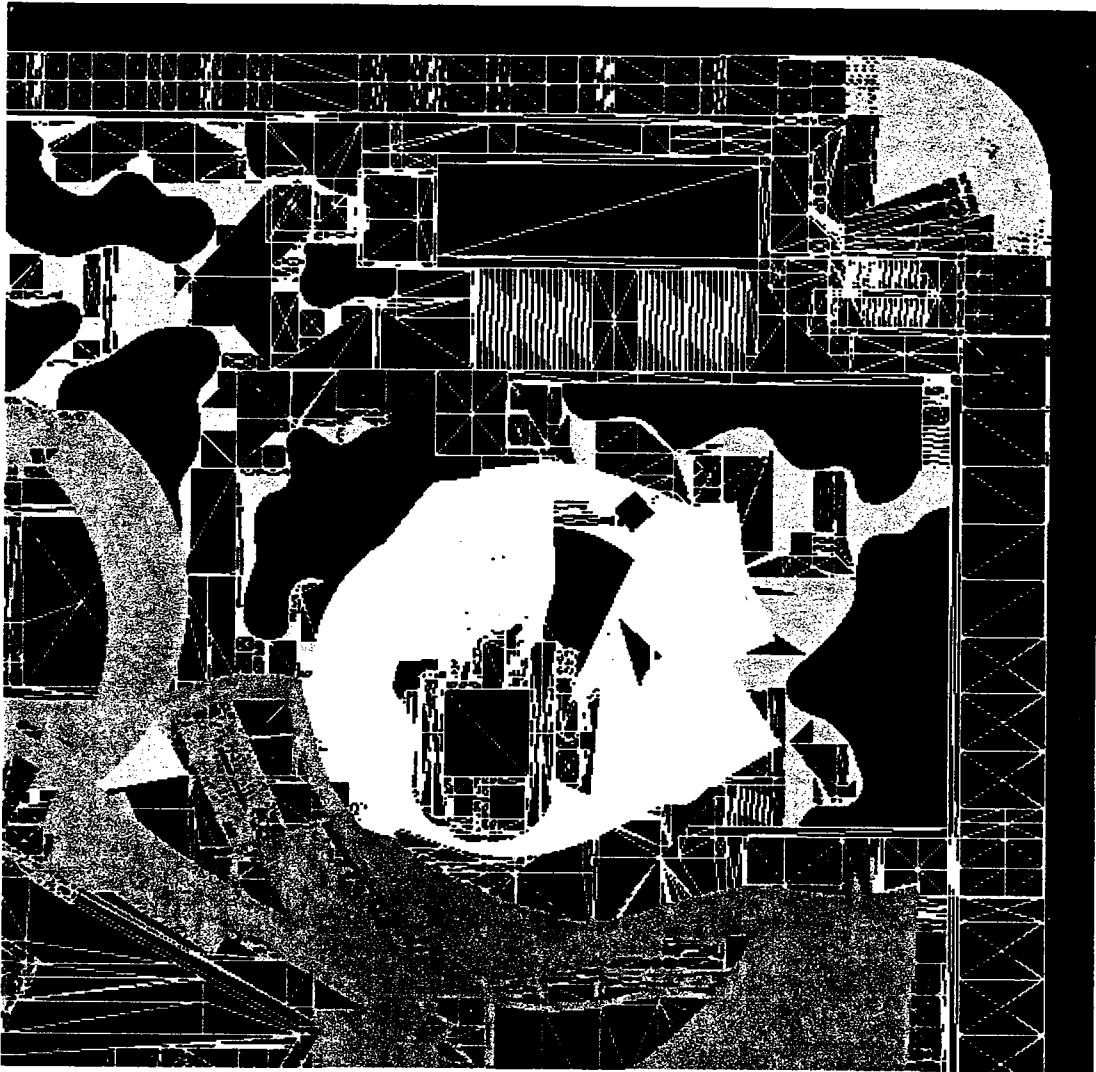


### Translation of Computer Files

Files were available in Initial Graphics Exchange Specification (IGES) format. These files were provided by Gehry's office. They were translated into Drawing Interchange File (DXF) formats using PolyTrans and SolidView Pro. These were tested in AGI32 and Lightscape. Two surfaces from the Founder's Room were missing.



The second set of files was delivered in DXF format. These files were sorted into two groups. One consisted of the north corner of the site including the Founder's Room. Unnecessary information (e.g., railings, etc.) were culled from the file to reduce the number of polygons. The other file consisted of the rest of the site, although it was later found that the CalArts Theater Marquee was missing.



The Founder's Room file was simulated in Lightscape but was found to be prohibitive in size (950,000+ vertices). A single sun position took in excess of three days of continuous computer run time. The file was culled and the remaining surfaces were combined into larger surfaces.

### **Missing Data**

The Gehry files did not contain information on surrounding buildings, such as the height and facade of the Promenade Towers.

The viewpoints for the upper floors were calculated in three dimensions and used as the viewpoint locations for the subsequent simulations.

## Simulations

Lightscape allows simulations with specific material characteristics to be done for hourly sun positions. The data is stored as a three-dimensional file, not just a single view. This allows the complete calculation of the lighting conditions resultant from a particular sun position. This is stored and can be subsequently viewed from multiple positions. (Several alternative programs require separate calculations from each viewpoint.)

The images produced can be color coded for possible sources of glare. Any yellow or red surface that coincides with a high specularity (e.g., polished stainless steel) represents a possible source of glare.

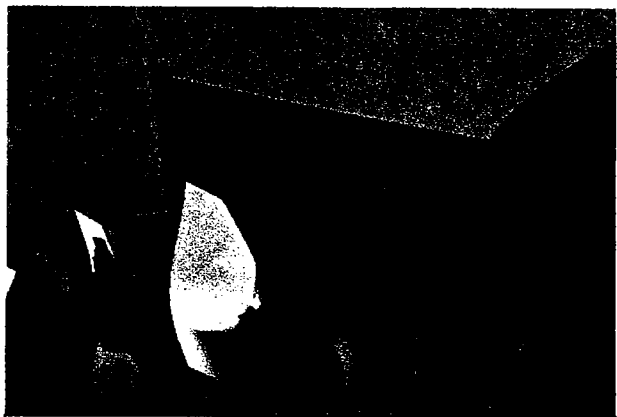
The polished and the brushed portions of the facade were examined separately.

### Seasonal Surveys at Half-Hour Intervals of the Founder's Room

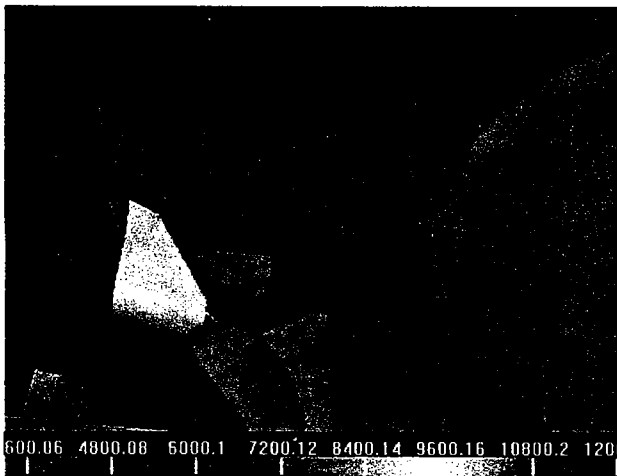
Complete simulations were run at half-hour intervals for all daylight hours on representative December (winter), March/September (spring/fall), and June (summer) days.



*Photo of Reflection from Polished Founder's Room*



*Simulation of Reflection from Computer Model*



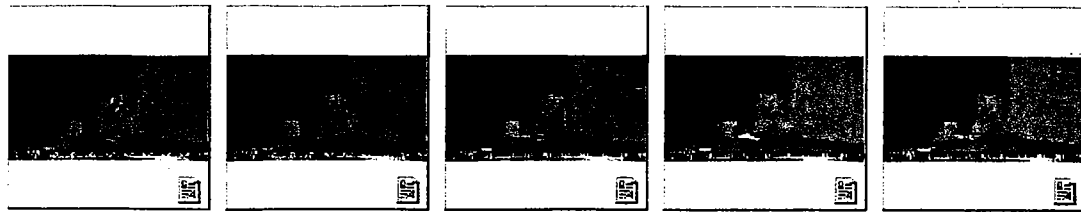
*Luminance Plot from Simulation*



*Luminance Plots of Founder's Room at Half-Hour Intervals for June*

Note the significant areas from 12:30 p.m. to a peak glare condition around 4:00 p.m.





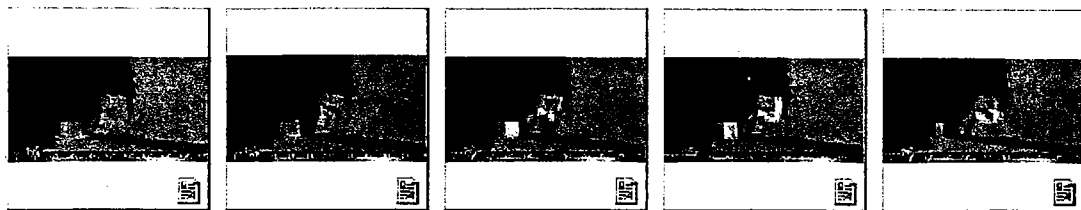
Sept21\_09.jpg

Sept21\_0930.jpg

Sept21\_10.jpg

Sept21\_1030.jpg

Sept21\_11.jpg



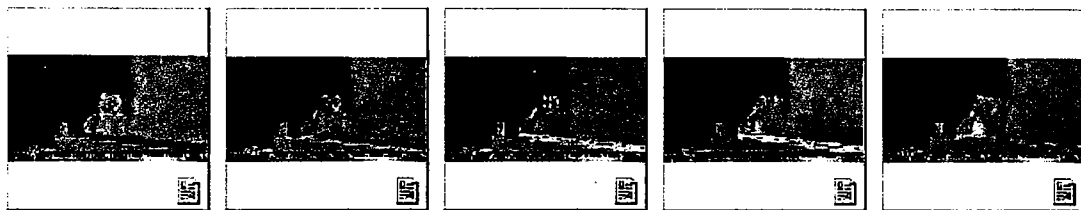
Sept21\_1130.jpg

Sept21\_12.jpg

Sept21\_1230.jpg

Sept21\_13.jpg

Sept21\_1330.jpg



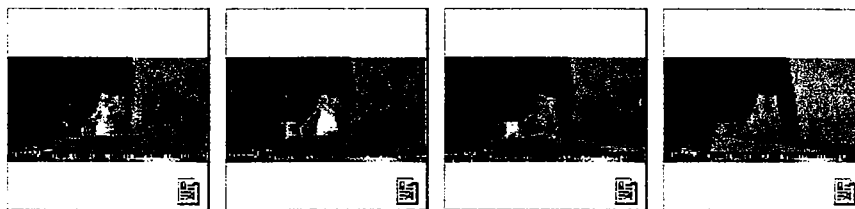
Sept21\_14.jpg

Sept21\_1430.jpg

Sept21\_15.jpg

Sept21\_1530.jpg

Sept21\_16.jpg



Sept21\_1630.jpg

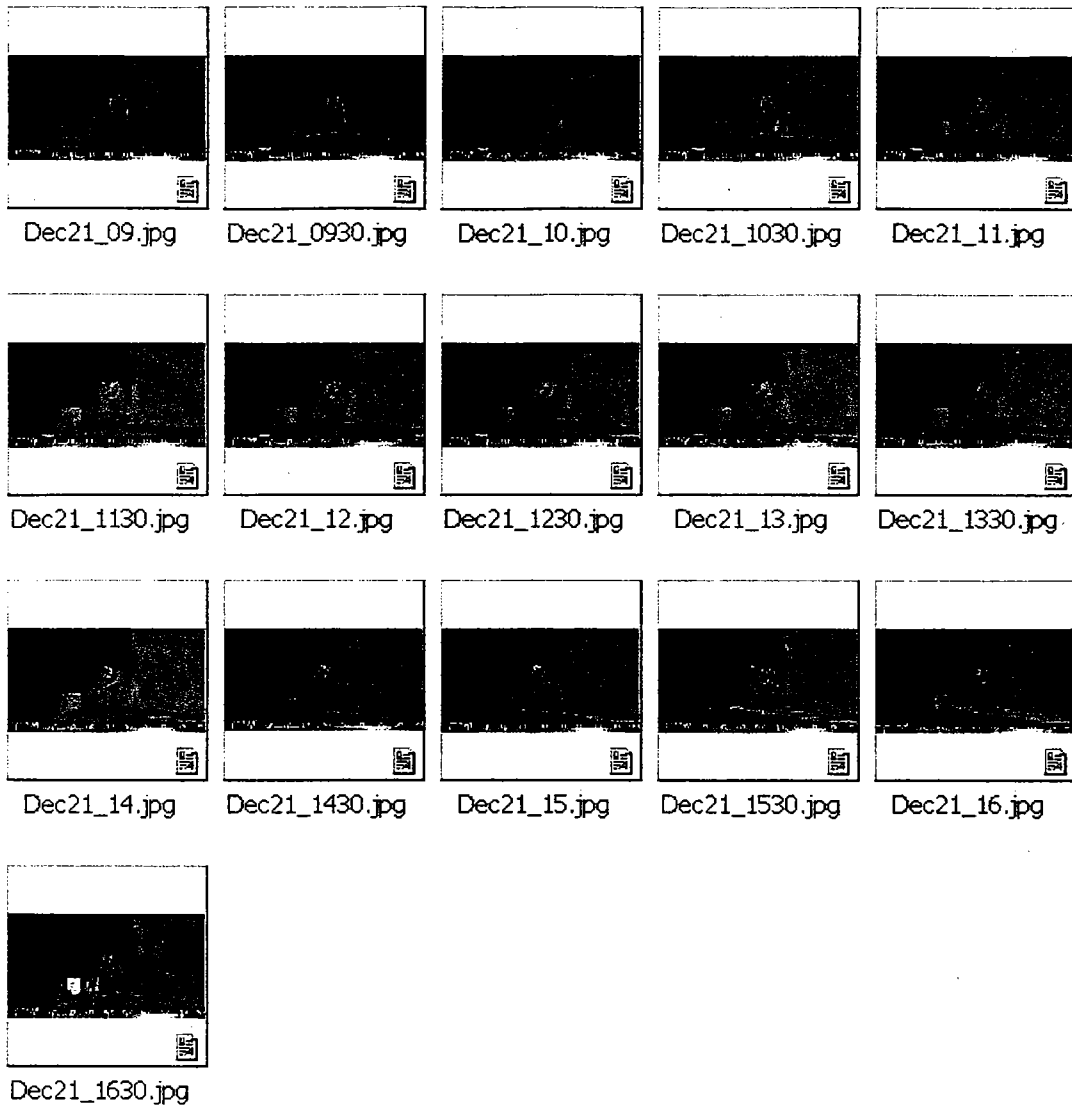
Sept21\_17.jpg

Sept21\_1730.jpg

Sept21\_18.jpg

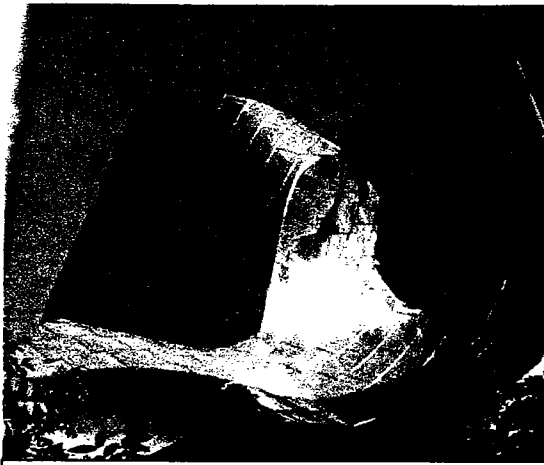
*Luminance Plots of Founder's Room at Half-Hour Intervals for Spring/Fall*

Note the continued likelihood of glare at somewhat earlier hours of the day.

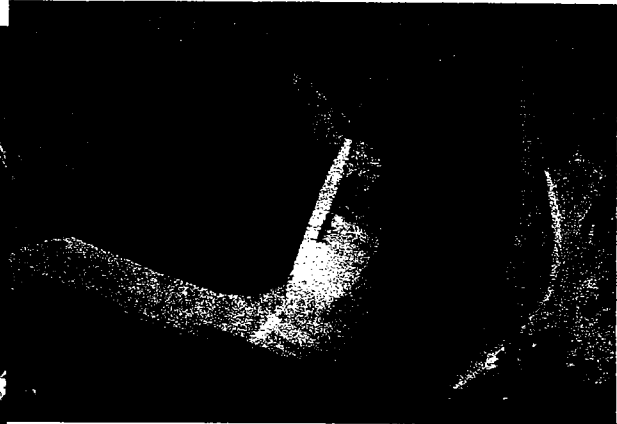


*Luminance Plot of Founder's Room at Half-Hour Intervals for December*

Note the reduced likelihood of glare in December due to the critical portions of the facade being shaded by other portions of the facade.



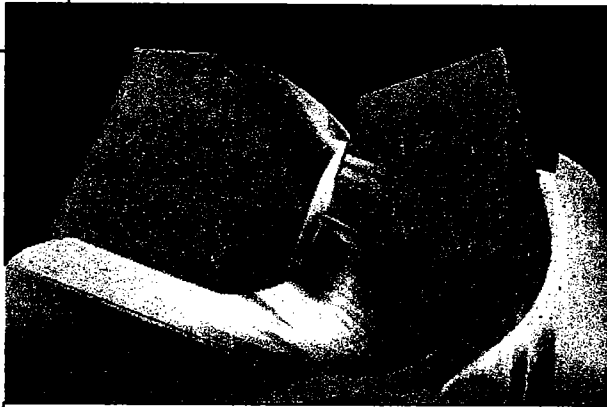
*Photograph of "Eye"*



*Simulation of "Eye"*

## Results

Luminance surveys of the Founder's Room confirm that there is significant light reflection from three surfaces, the "eye" and the two "knees." The eye reflectance is a compound reflectance from two adjacent surfaces and the eye itself, resulting in the equivalent of a taillight or bicycle reflector. The light is very bright and collimated. Furthermore, the surface is well above the level of the trees; thus, there is no filtering effect. The main wing of the Disney Hall immediately to the southwest of the Founder's Room shades the "eye" in much of September and the winter months, but the reflections reappear in the summer months.

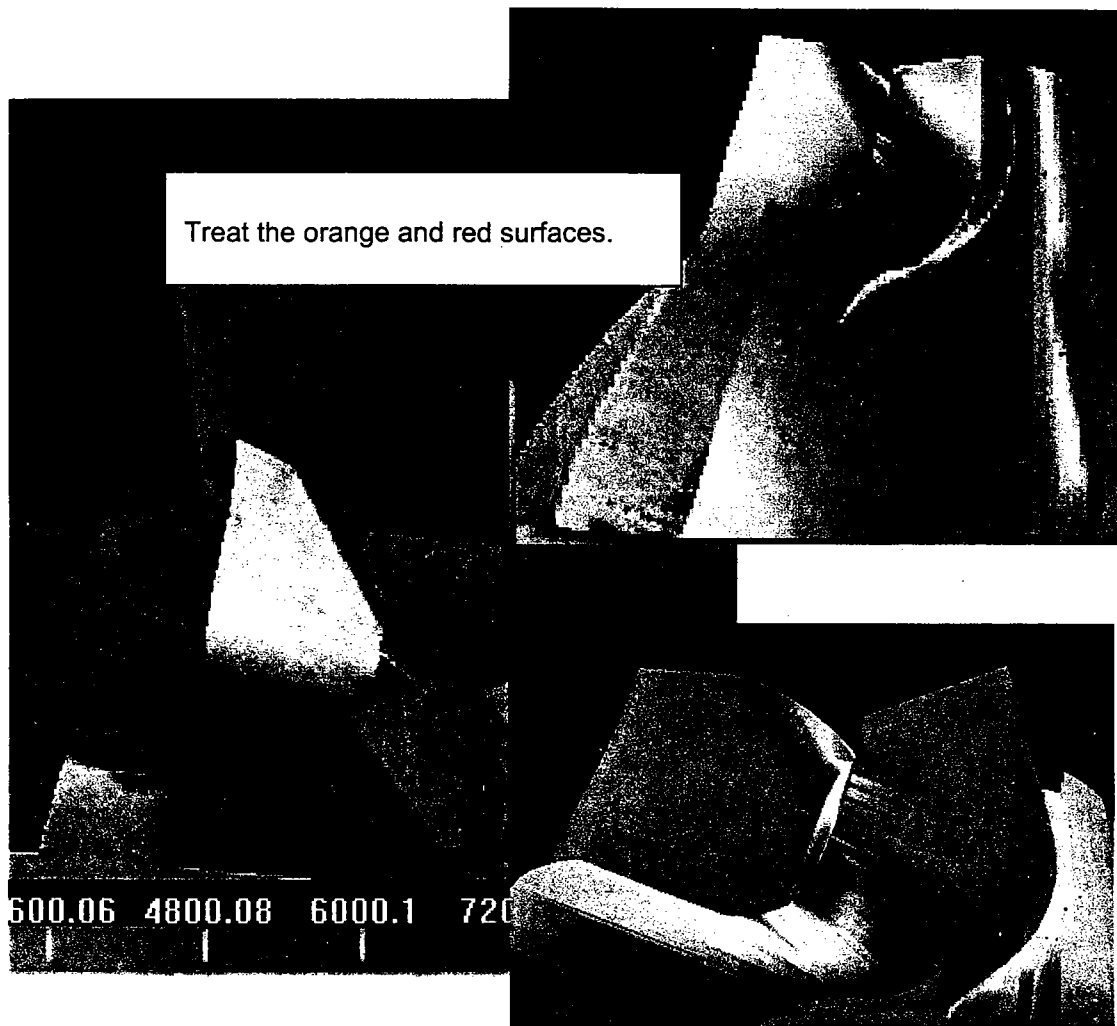


*Luminance Plot of "Eye"*

## Summary

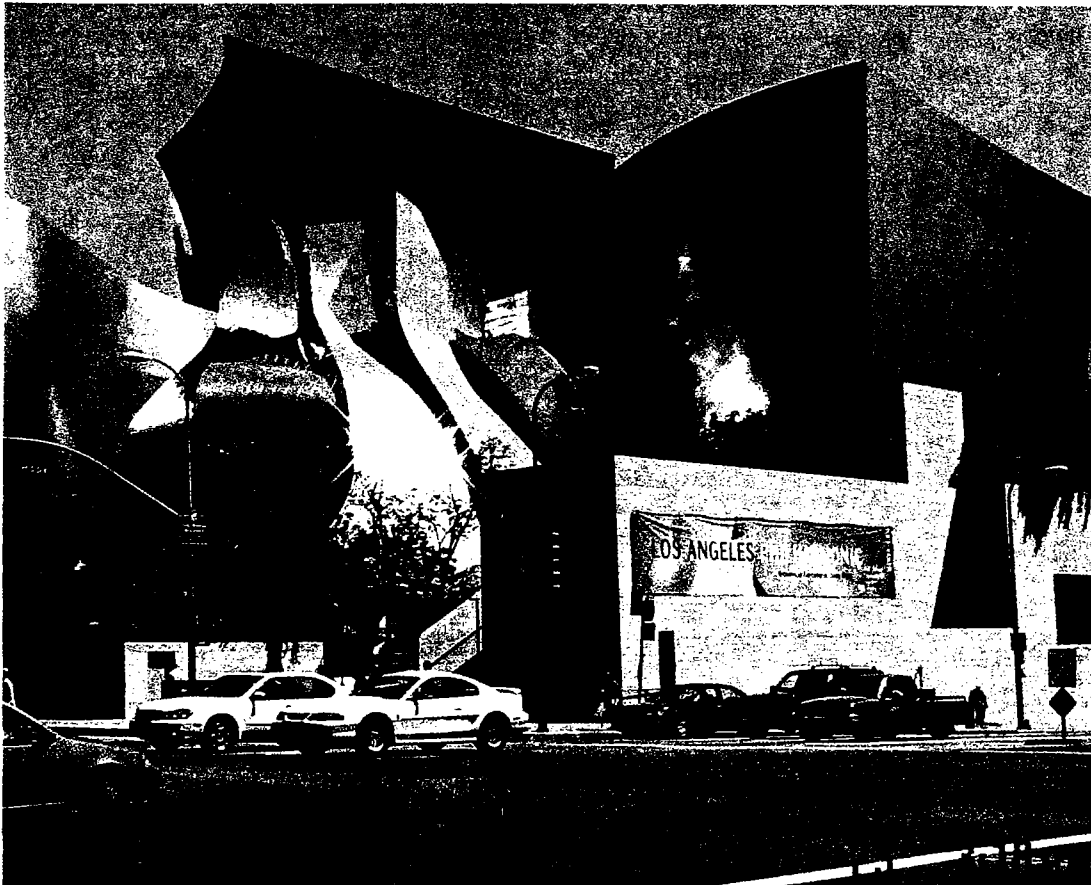
The upper portions of the Founder's Room facing the Promenade Towers will, at various times, send a beam of collimated light into the balconies and apartments. This will cause visual discomfort, which has been simulated, and is likely to cause an increase in heat gain; however, the exact heat gain has not been measured or simulated. The lower surfaces of the "knees" have high reflectance as well. The lower floors of the Promenade Towers are generally shielded or filtered by the trees, although a few units may "see" between the trees. Unfortunately, the uppermost floor will still get some direct reflection, even from the lower panels.

The surfaces indicated in orange or red should be treated.



### **Glare at Intersection of 1<sup>st</sup> and Hope Streets**

The intersection of 1<sup>st</sup> Street and Hope Street occurs immediately to the north of the Founder's Room. There are moments when the sun is reflected directly off the Founder's Room into the intersection. This can interfere with a clear view of traffic and pedestrians, especially when heading south on Hope Street and turning left or heading east on 1<sup>st</sup> Street.



### **Visual and Photographic Survey**

Several visual and photographic surveys have been made of the intersection. These found that the "hot spots" and reflections varied significantly throughout the day, often in an unexpected manner.

Photographic surveys of the Founder's Room found that there is significant light reflection into the intersection from two more surfaces and the corner of a third surface; this is in addition to one of the surfaces that had already been shown to reflect onto the Promenade Towers.

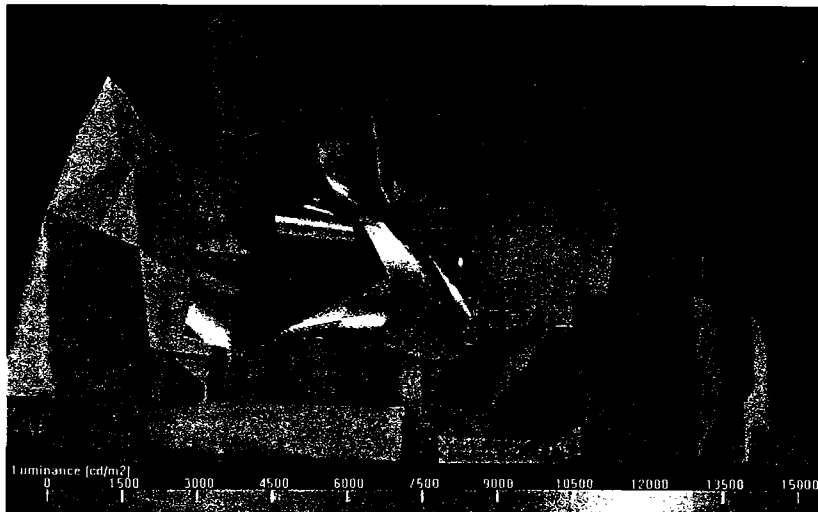
Because the two additional surfaces are curved (like a neck on top and a bulge half way down), they throw a light beam into the intersection at various times throughout the afternoon. Different portions are involved at different times.



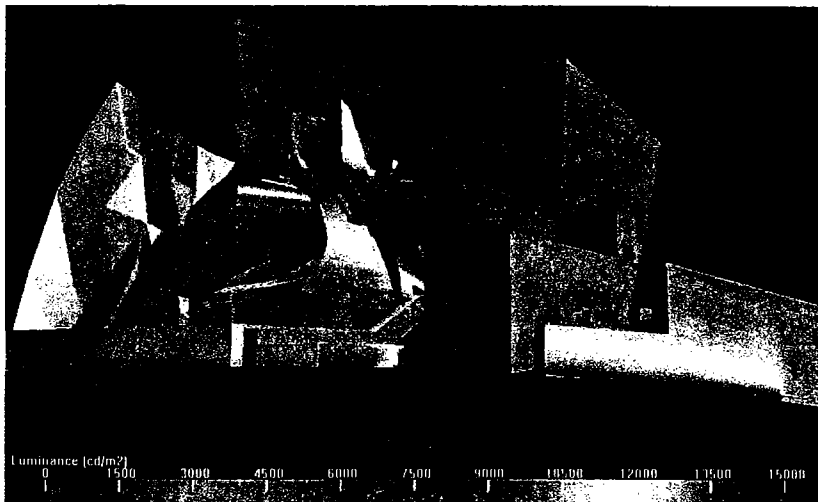
### Computer Surveys

Again, the Founder's Room file was simulated in Lightscape, but was found to be prohibitive in size. A single sun position took in excess of three days of continuous computer run time. The file was culled, and the remaining surfaces were combined into larger surfaces. The portion of the Founder's Room that was not visible from the intersection was discarded for this simulation and the other background surfaces were simplified. For this reason, the resulting simulations show light hitting some of the surfaces behind the Founder's Room, which does not occur in the real building and does not interfere with the simulation.

Two kinds of simulations were performed. The first was taken from the eye level of a driver in the left-turn lane heading south on Hope Street. The second was taken from a diagonal point across the intersection, with a wide angle view.



*View from Left-Turn Lane, Bus Height*



*View from Diagonal Point Across Intersection, or Center of Intersection*

Again, different surfaces threw glare at different times to one or more of the traffic locations.



The rightmost surface (seen on edge) throws glare at the Promenade Towers. The surface in the middle throws glare, mostly from the middle and upper portion of the bulge. The surface to the left throws glare only from the top of the bulge.

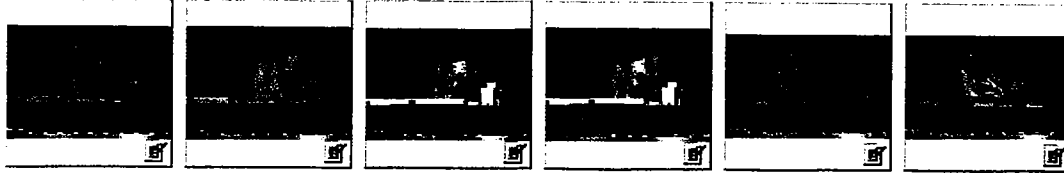
The surfaces to the right are benign. The top and the bottom of the middle surface and the toe of the left surface throw some glare. (In other images, the toe is brighter and the others have faded.)



#### **Seasonal Surveys at Half-Hour Intervals of the Founder's Room**

Complete simulations were run at half-hour intervals for all daylight hours on representative December (winter), March/September (spring/fall), and June (summer) days.





1stnHopeJun0600b 1stnHopeJun063... 1stnHopeJun070... 1stnHopeJun073... 1stnHopeJun120... 1stnHopeJun133...  
.jpg



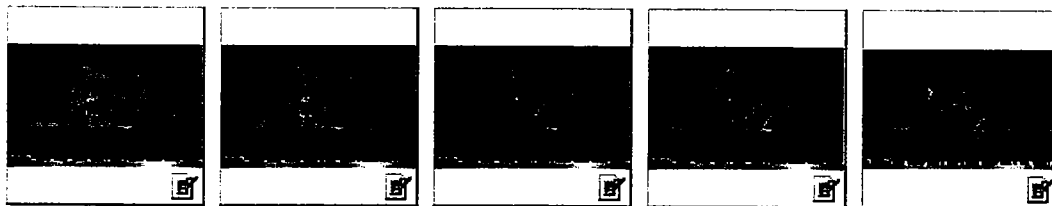
1stnHopeJun140... 1stnHopeJun143... 1stnHopeJun150... 1stnHopeJun153... 1stnHopeJun160... 1stnHopeJun163...



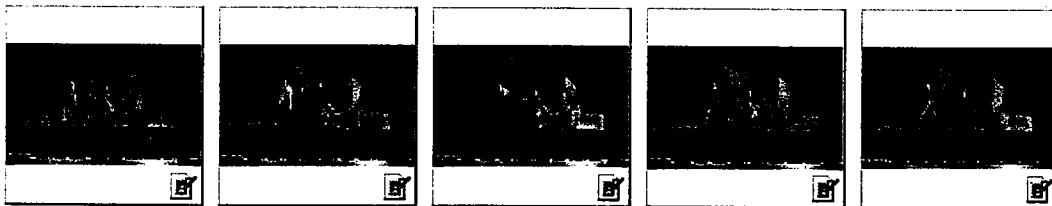
1stnHopeJun170... 1stnHopeJun173... 1stnHopeJun180... 1stnHopeJun183... 1stnHopeJun190... 1stnHopeJun193...

There is some exposure early in the day, but most exposure occurs late in the day. Note the significant areas from 12:30 p.m. to a peak glare condition around 4:00 p.m.

The stone facade facing Hope Street receives heavy doses of light but does not actually represent a problem because it is a matte, diffusing surface.

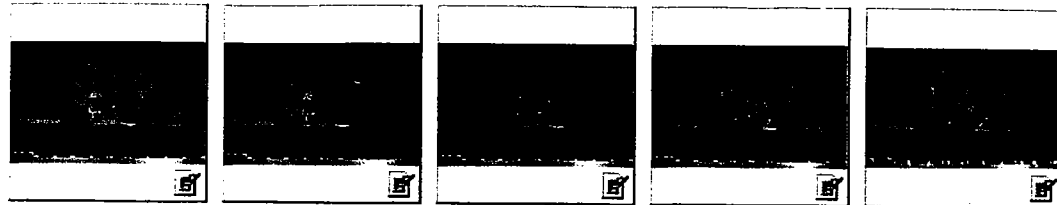


1stnHopeMar12... 1stnHopeMar12... 1stnHopeMar13... 1stnHopeMar13... 1stnHopeMar14...

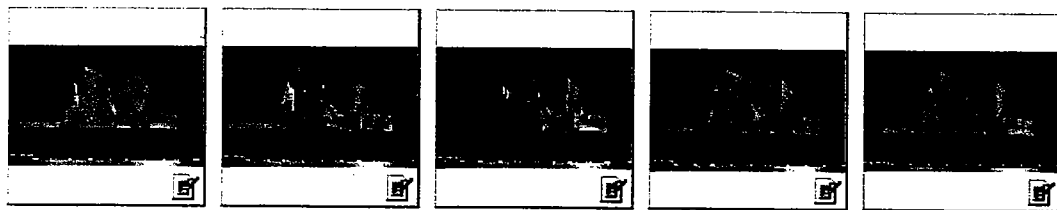


1stnHopeMar15... 1stnHopeMar16... 1stnHopeMar17... 1stnHopeMar18... 1stnHopeMar18...

Note the marked decrease in the likelihood of glare. Unlike the southern facades and the CalArts Theater Marquee, the sun barely strikes the Founder's Room, from the east in the morning and from the west in the evening.



1stnHopeMar12... 1stnHopeMar12... 1stnHopeMar13... 1stnHopeMar13... 1stnHopeMar14...



1stnHopeMar15... 1stnHopeMar16... 1stnHopeMar17... 1stnHopeMar18... 1stnHopeMar18...

In winter months, there is light only from the west, and it is not problematic.

## Results

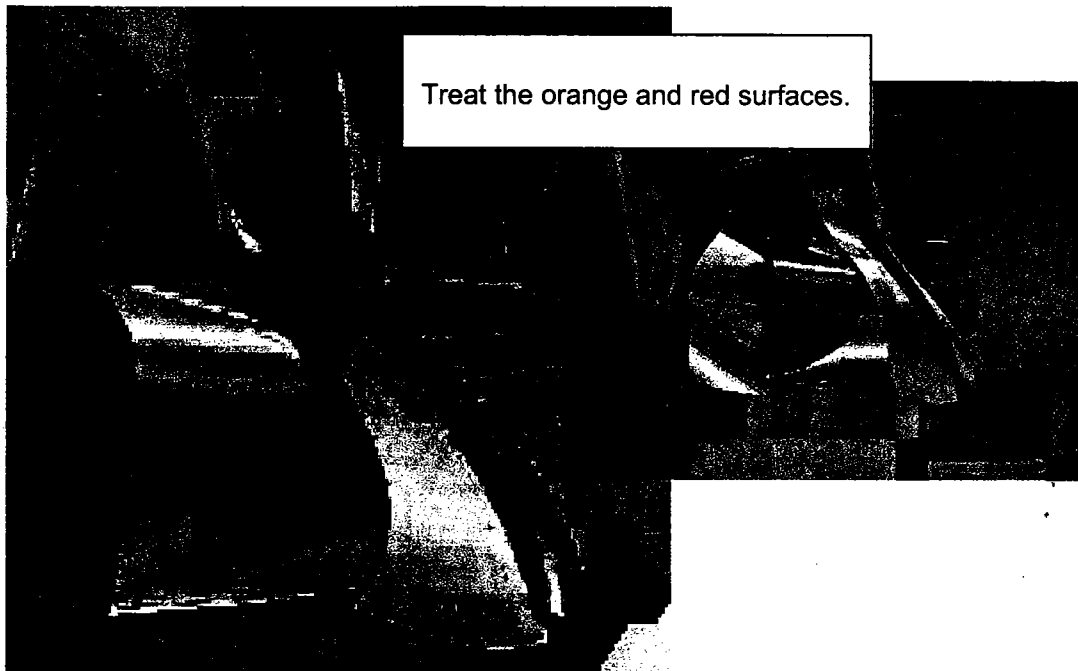
Based on simulations, drive-through films were made heading south on Hope Street and turning left or going straight down the hill. No additional difficulties were encountered. If anything, it was observed that the glare from the higher portions of the surfaces (the "necks") were bright and somewhat distracting but above the direct view while making a turn. The tops of the surfaces do not need to be treated.

The photographs indicate that the trees are extremely important in shielding the lower edges of the surfaces. If there is any doubt about the maintenance or survival of the trees, the bottom portions of the surfaces should be treated.

The middle (or bulging) portion, the top of the bulge, and the middle of the neck all reflect directly into the intersection at one time or another and should be treated.

## Summary

The three surfaces shown should be treated. The entire right surface should be treated. The middle of the middle surface should be treated. The top of the bulge on the left surface should be treated. The trees must be maintained, or the bottom of the left and far left surfaces should be treated.



### **Glare at Intersection of 2<sup>nd</sup> and Hope Streets (CalArts Theater Marquee)**

The Roy and Edna Disney California Arts Theater (REDCAT) occupies the southwest corner of the site. It is embedded into the main block of the building. The marquee is the only opportunity for CalArts to announce their presence.

The intersection of 2<sup>nd</sup> Street and Hope Street occurs immediately to the west. There are moments when the sun is reflected directly off the marquee into the intersection. This can interfere with a clear view of traffic and pedestrians, especially when heading north on Hope Street and/or turning right onto 2<sup>nd</sup> Street.



*Heading North*



*Turning East onto 2<sup>nd</sup> Street*

Portions of the offending surfaces have been treated to create a different surface texture in the overall form of a cat. This is effective in reducing the focusing from the middle of those surfaces; however, above and below the cat, the surfaces still result in glare.

### **Visual and Photographic Survey**

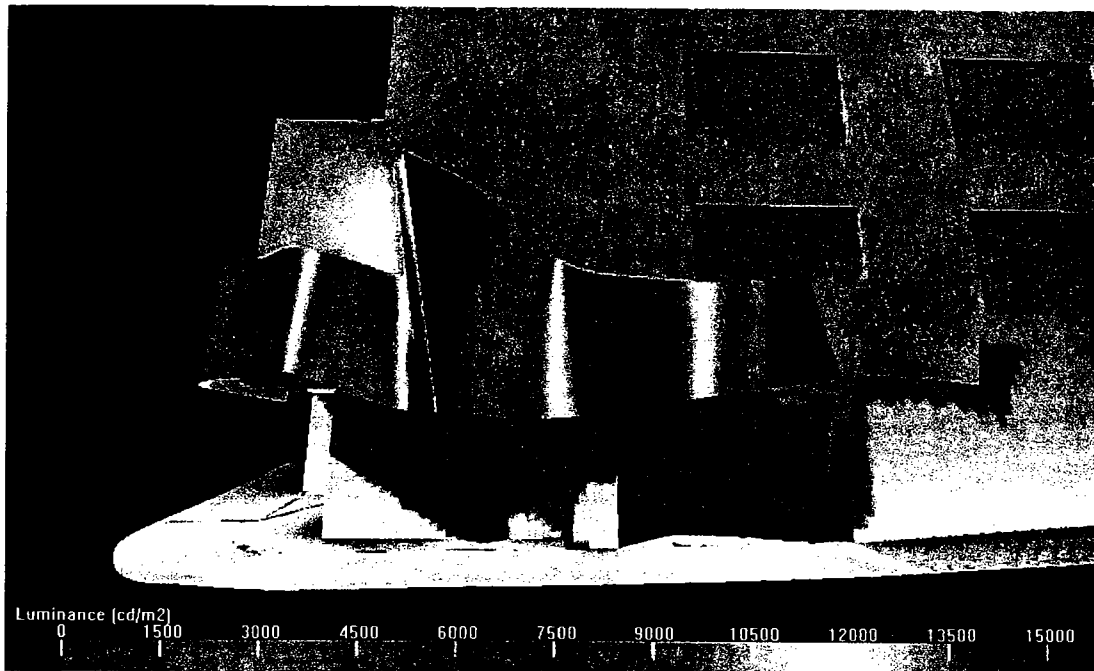
Several visual and photographic surveys have been made of the intersection. These surveys found that the "hot spots" and reflections varied significantly throughout the day, often in an unexpected manner.

Visual surveys of the CalArts Theater Marquee found that there is significant light reflection into the intersection from two areas on the surface, resulting in some

interference with traffic. The majority of the surface results in beamed and focused sunlight (solar gain) onto the ground in front of the marquee. This produces significantly elevated surface temperatures, which will be discussed in a later section of this report.

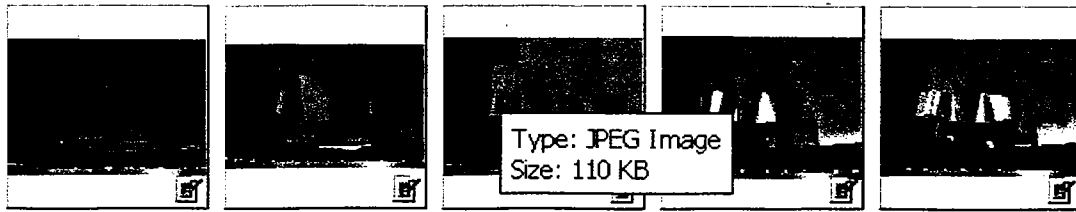
### Computer Surveys

Again, the marquee was simulated in Lightscape. The worst situation occurs in late summer afternoons. There are two areas shown in the simulation that require attention.

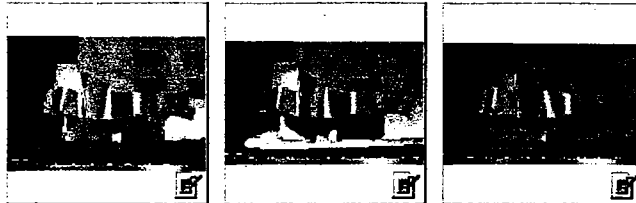


### Seasonal Surveys at Half-Hour Intervals of the Founder's Room

Complete simulations were run at half-hour intervals for all daylight hours on representative December (winter), March/September (spring/fall), and June (summer) days. In some instances, the luminance plots are color coded to a higher scale, in order to make the areas of greatest luminance stand out. It becomes apparent that, at one time or another, almost all the regions of the marquee reflect glare. It is also interesting to note that the vertical surfaces on the south facade continue to throw significant amounts of light, even through the winter sun angles.



MarqueeJun1100.j MarqueeJun120... MarqueeJun130... MarqueeJun140... MarqueeJun150...  
pg

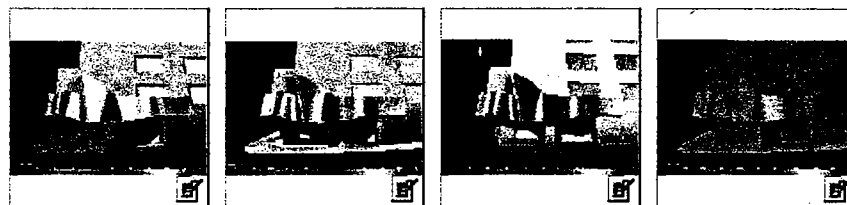


MarqueeJun160... MarqueeJun170... MarqueeJun180...

*Luminance Plots of CalArts Theater Marquee at Hourly Intervals for June*

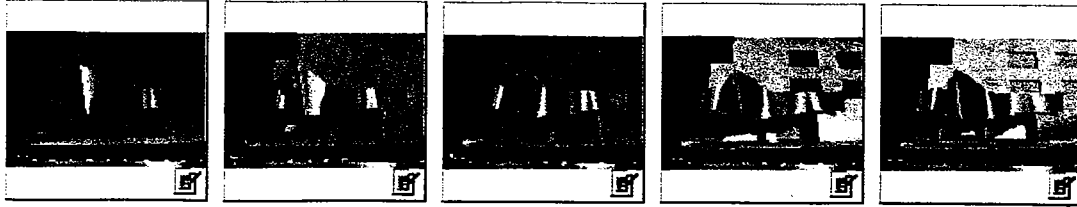


MarqueeMar100... MarqueeMar110... MarqueeMar120... MarqueeMar130... MarqueeMar140...

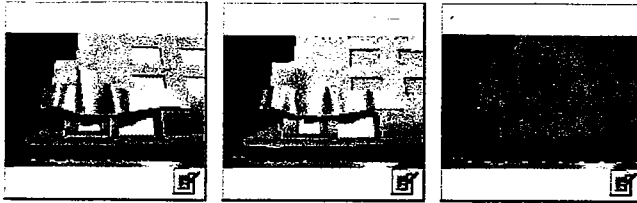


MarqueeMar150... MarqueeMar160... MarqueeMar1700.j MarqueeMar180...

*Luminance Plots of CalArts Theater Marquee at Hourly Intervals for March*



MarqueeDec100... MarqueeDec110... MarqueeDec120... MarqueeDec130... MarqueeDec140...

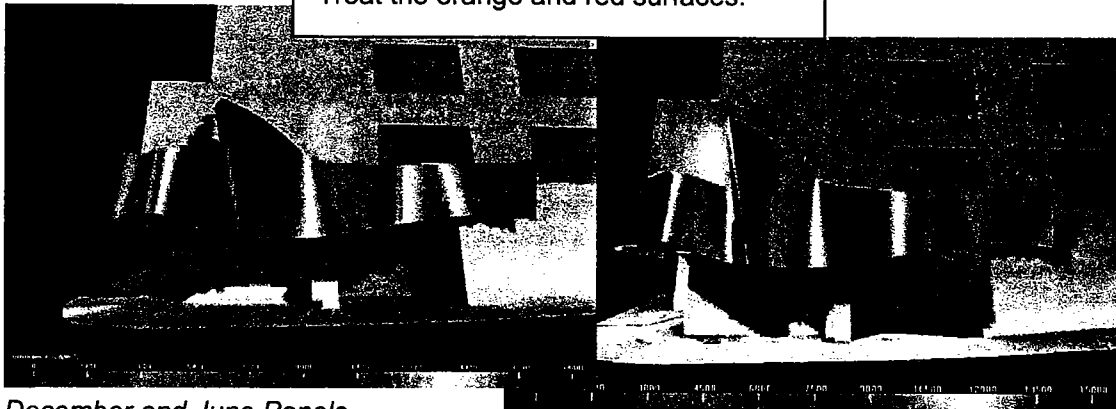


MarqueeDec150... MarqueeDec160... MarqueeDec170...

*Luminance Plots of CalArts Theater Marquee at Hourly Intervals for December*

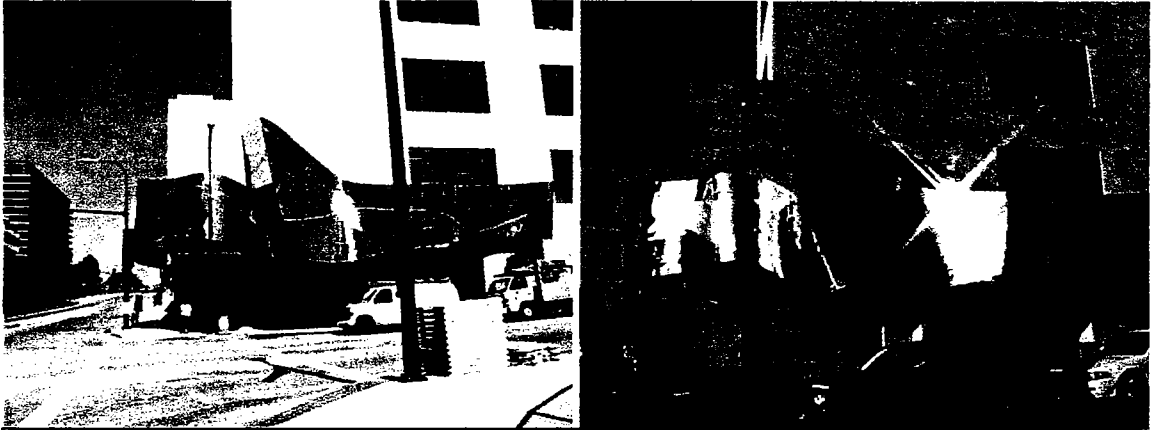
The simulation indicates that there are four regions requiring treatment. The “prow” of the marquee and a portion to the left of it are dangerous in spring and winter months. The corner at the intersection and the bay to the right are dangerous in the summer months.

Treat the orange and red surfaces.



*December and June Panels*

For the first time, the simulations and the photographs seem to indicate slightly different outcomes. The photograph and the simulation of the June 4:00 p.m. glare seem to match exactly. However, the photograph and the simulation of the March 2:00 p.m. glare present somewhat differently. Although the “prow” of the marquee is at a high luminance level, the glare itself is cast downward and parallel to 2<sup>nd</sup> Street in such a tight fashion that the traffic at the intersection does not see it. Where the glare image has diffused to a lower intensity, it is seen by traffic but is not problematic. In June, the “prow” throws light into the intersection.



*December and June Photographs*

A careful examination of the other photographs (not shown) indicates that the “prow” does not throw glare into the intersection at any other times; however, it throws glare into the street and sidewalk. This may present a temperature buildup problem (examined later in this report) but does not present a traffic problem. It may annoy traffic traveling west on 2<sup>nd</sup> Street, but since the traffic control light is free from glare, it is not problematic. It would be safest to treat all four surfaces, but it may not be necessary to treat the “prow.”

## **Results**

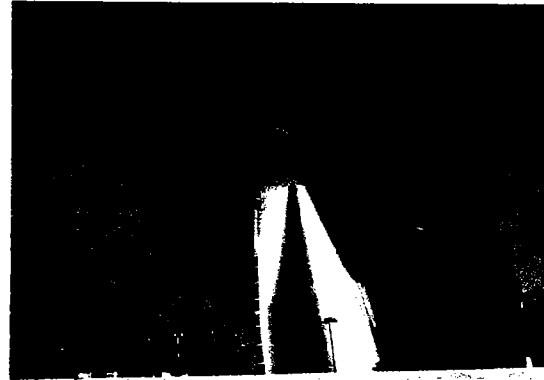
Both the photographs and the simulations indicate that there are two regions that require further treatment. Portions of the offending areas have been treated to create a different surface texture in the overall form of a cat. This is effective in reducing the focusing from the middle of those surfaces; however, above and below the cat, there is still more than enough polished surface to result in glare.

In keeping with the nature of CalArts as an institution, there may be some creative way to treat those surfaces. Possible treatment options include brushed treatment, etched treatment, or using a different color of surface film (e.g., red film covering the entire segment or only the background to the cat) to preserve the outline of the cat or creating a red cat. This study simply indicates that the surface requires treatment and suggests that CalArts or the architect invent their own method of diffusing or reducing the reflectance and/or specularly.



### Glare from Brushed Stainless Panels on the Hope Street Elevation

The Founder's Room is not the sole source of glare when seen from the Promenade Towers. Unfortunately, the brushed stainless steel surfaces can also create glare. Glare from the brushed stainless steel surfaces is less extreme but consists of a much larger total surface area. The same procedure was used to examine the instances of possible glare, the level of such glare, and what amelioration might prove useful.



*Photograph of "Hat" Conic section*



*Simulation of "Hat"*

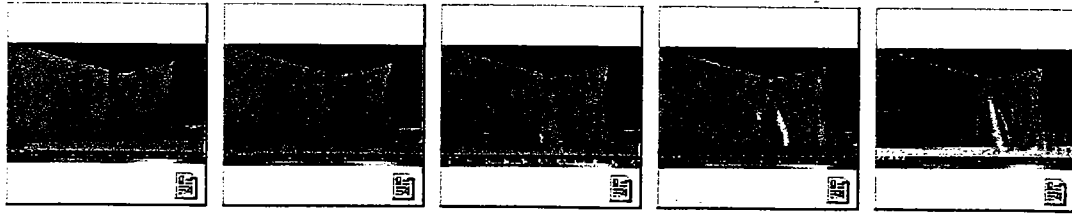


*Luminance Plot of "Hat"*

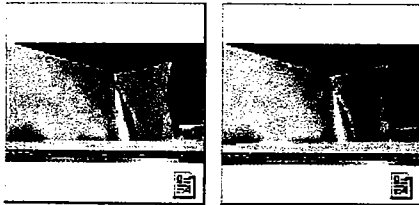
The peak luminances generated by the cone approach those generated by the Founder's Room. Fortunately the surface is convex and brushed stainless rather than concave and polished stainless. The glare will be less than that of the Founder's Room, but should be evaluated with a luminance histogram to be certain that it is not disability glare.

### Seasonal Surveys at Hourly Intervals of the Hope Street Elevation

Complete simulations were run at hourly intervals for all daylight hours after noon on representative December (winter), March/September (spring/fall), and June (summer) days.



SWJune21\_1200... SWJune21\_1300... SWJune21\_1400... SWJune21\_1500... SWJune21\_1600...

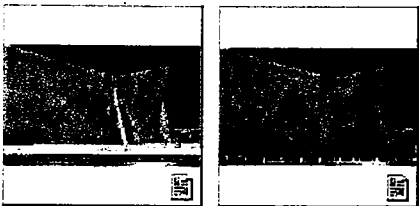


SWJune21\_1700... SWJune21\_1800...

*Luminance Plots of Hope Street Elevation at Hourly Intervals Starting at Noon for December*

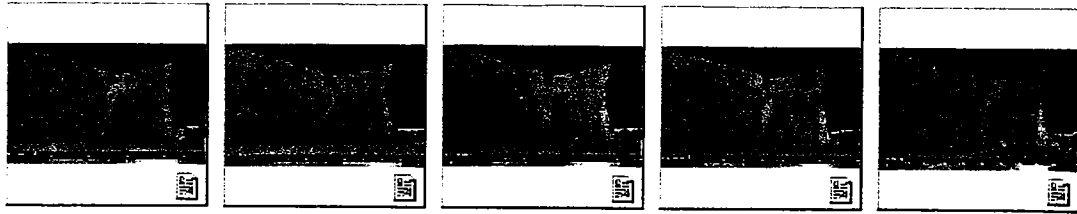


SWSept21\_1200... SWSept21\_1300... SWSept21\_1400... SWSept21\_1500... SWSept21\_1600...



SWSept21\_1700... SWSept21\_1800...

*Luminance Plots of Hope Street Elevation at Hourly Intervals Starting at Noon for September*



SWDec21\_1200.jp SWDec21\_1300... SWDec21\_1400... SWDec21\_1500... SWDec21\_1600...

*Luminance Plots of Hope Street Elevation at Hourly Intervals Starting at Noon for December*

## Results

Luminance surveys of the Hope Street elevation confirm that there is significant light reflection from the conic shape and surprisingly little light reflection from the larger surfaces. Unlike the polished surfaces of the Founder's Room, the luminances are diffused rather than focused.

Again, the trees form an important part of the filtering, especially for the lower zones where the largest reflective areas appear.

### Glare from Brushed Stainless Panels on the 2<sup>nd</sup> Street Elevation

The Promenade Towers extend further southwest on Hope Street than the main building of the Disney Hall. This means that the Promenade Towers are exposed to the 2<sup>nd</sup> Street elevation as well. The same procedure was used to examine the instances of possible glare, the level of such glare, and what amelioration might prove useful.

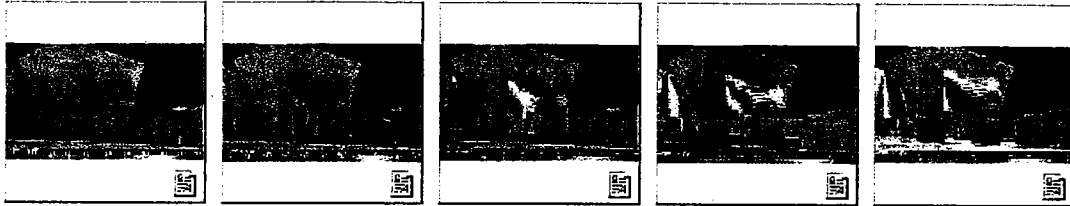
### Seasonal Surveys at Hourly Intervals of the 2<sup>nd</sup> Street Elevation

Complete simulations were run at hourly intervals for afternoon hours on representative June (summer) days.

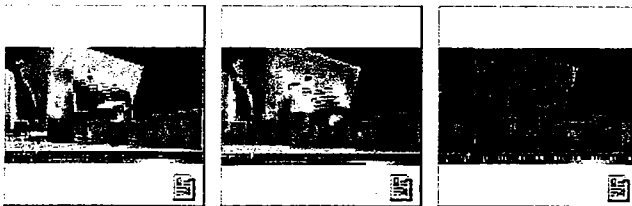
Fortunately, the largest surface, which was aimed slightly upward towards the Promenade Towers, was on the 2<sup>nd</sup> Street elevation, set back quite some distance from 2<sup>nd</sup> Street, itself. In fact, the surface is not visible from the street level, but only from the south end of the Promenade Towers and also from more distant buildings such as the Bonaventure Hotel and restaurant, the BP (formerly Interstate Bank) building, and the Wells Fargo buildings.

## Results

At 4:00 p.m. and 5:00 p.m., there are indications of possible glare.



SWEJune21\_1200.j SWEJune21\_130... SWEJune21\_140... SWEJune21\_150... SWEJune21\_160...  
pg



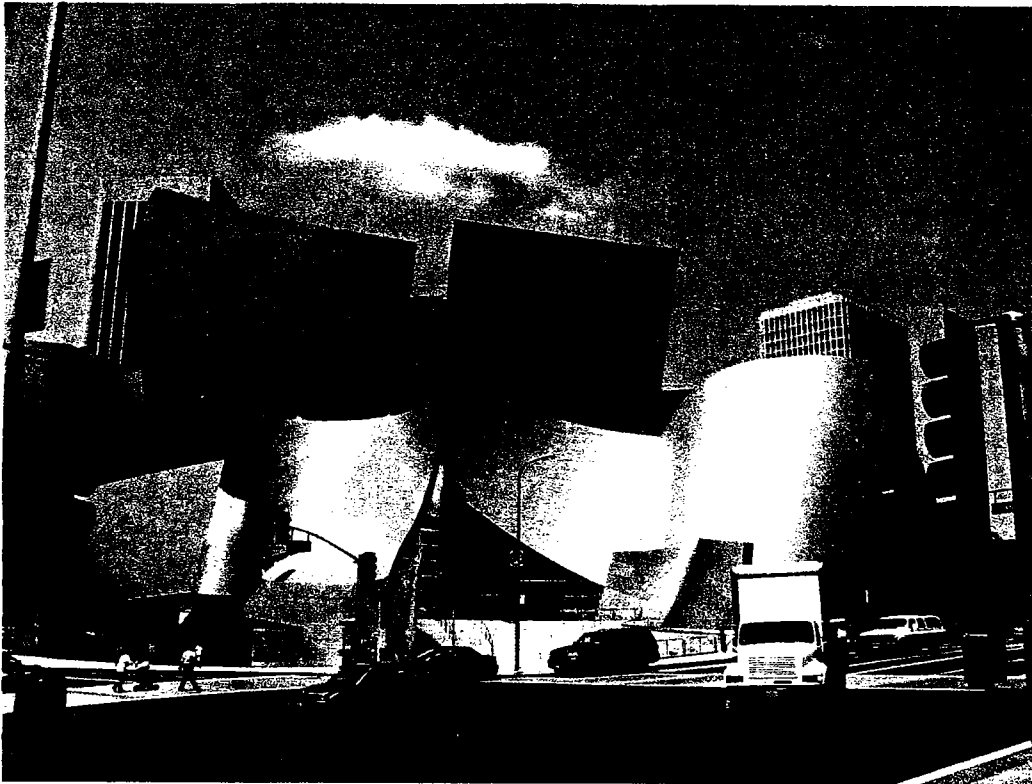
SWEJune21\_170... SWEJune21\_180... SWEJune21\_190...

*2<sup>nd</sup> Street Elevation from Southwest at Hourly Intervals for June*

Again, this is a brushed stainless surface rather than a polished stainless steel surface. In addition, the observation points are more distant. However, this surface should also be considered in a histogram.

### Glare at Intersection of 1<sup>st</sup> and Grand Streets

There are no polished stainless steel surfaces facing the intersection, but the possibility remained that the brushed stainless steel panels, which reach very high luminance levels, might otherwise provide an unexpected point of glare or high enough backgrounds that the eye would be drawn to them and become adapted to the higher level.



### **Seasonal Surveys at Half-Hour Intervals of the Intersection of 1<sup>st</sup> and Grand Streets**

Photographs were taken at half-hour intervals throughout the day of the spring equinox and the approximate summer solstice. (There was some weather difficulty that required a half day to be photographed a week later.)



1stnGrand0700...



1stnGrand0730...



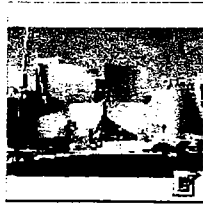
1stnGrand0800...



1stnGrand0830...



1stnGrand0900...



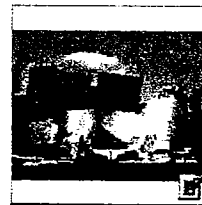
1stnGrand0930...



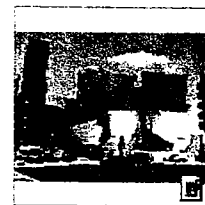
1stnGrand1000...



1stnGrand1030...



1stnGrand1100...



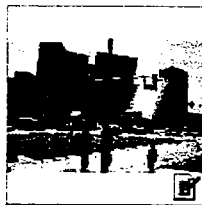
1stnGrand1130...



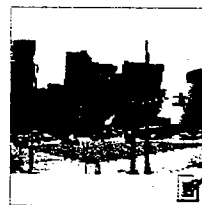
1stnGrand1200...



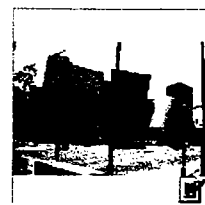
1stnGrand1230...



1stnGrand1300-...



1stnGrand1330...



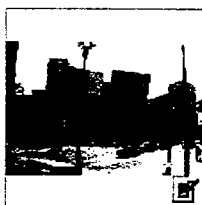
1stnGrand1400...



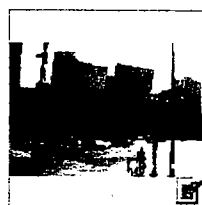
1stnGrand1430...



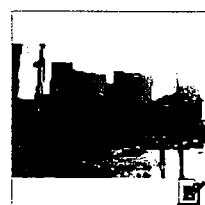
1stnGrand1500...



1stnGrand1530...



1stnGrand1600-...



1stnGrand1630...



1stnGrand1700...



1stnGrand1730...



1stnGrand1800.JP

*Photographs of the Intersection of 1<sup>st</sup> and Grand Streets at Half-Hour Intervals for June*

The only glare occurs late in the day from the sun and not the building.



1stGrnd0630.JPG



1stGrnd0800.JPG



1stGrnd0830.JPG



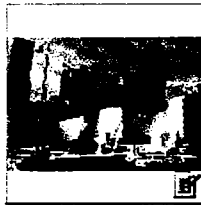
1stGrnd0930.JPG



1stGrnd1000.JPG



1stGrnd1030.JPG



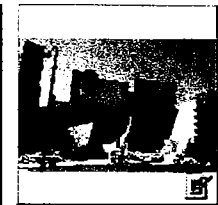
1stGrnd1100.JPG



1stGrnd1130.JPG



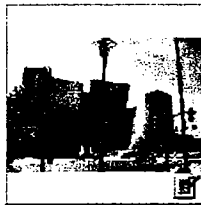
1stGrnd1200.JPG



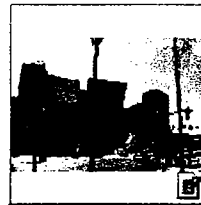
1stGrnd1230.JPG



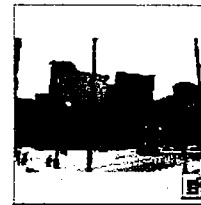
1stGrnd1300.JPG



1stGrnd1330.JPG



1stGrnd1400.JPG



1stGrnd1430.JPG

*Photographs of the Intersection of 1<sup>st</sup> and Grand Streets at Half-Hour Intervals for March*

## Results

Although there are very bright surfaces, they do not obscure or backlight pedestrians in the crosswalks or other critical ground level information. Surprisingly, the early morning distribution is the most distracting. Later in the day, the levels are higher, but the distribution is more even. After noon, the brightness is somewhat reduced. During the summer, the later hours produce some glare from the sun position but not from the building.

## Glare at Intersection of 2<sup>nd</sup> and Grand Streets

There are no polished stainless steel surfaces facing the intersection, but the possibility remained that the brushed stainless steel panels, which reach very high luminance levels, might otherwise provide an unexpected point of glare or high enough backgrounds that the eye would be drawn to them.

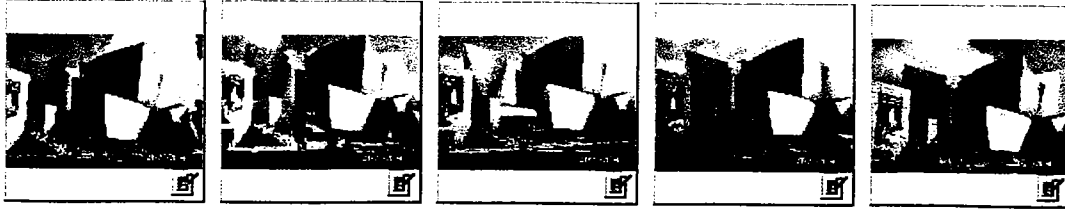
### Seasonal Surveys at Half-Hour Intervals of the Intersection of 2<sup>nd</sup> and Grand Streets

Photographs were taken at half-hour intervals throughout the day of the spring equinox and the approximate summer solstice. (There was some weather difficulty that required a half day to be photographed a week later.)



Note that the upper portion of the roof over the Patina Restaurant is glowing so strongly that the photo simply records it as pure white. Fortunately, it does not focus a beam, so there is no glare (normally indicated by lens flare) or direct interference with traffic.





2ndnGrandxxx1.JPG 2ndnGrandxxx2... 2ndnGrandxxx3... 2ndnGrandXXX4... 2ndnGrandxxx5...  
G



2ndnGrnd0700.JPG 2ndnGrnd0730.JPG 2ndnGrnd0800.JPG 2ndnGrnd0830.JPG 2ndnGrnd0900.JPG



2ndnGrnd1030.JPG 2ndnGrnd1100.JPG 2ndnGrnd1230.JPG 2ndnGrnd1300.JPG 2ndnGrnd1330.JPG

*Photographs of the Intersection of 2<sup>nd</sup> and Grand Streets at Half-Hour Intervals for June*

Note that there are some photographs that are not clearly time-stamped and are therefore labeled in a sequential fashion. There is no glare in the photographs, so the time stamp is not critical. (All of the above photographs are courtesy of Sapphos Environmental, Inc.)



*Photographs of the Intersection of 2<sup>nd</sup> and Grand Streets at Half-Hour Intervals for March*

## Results

The segment that forms the roof of the Patina Restaurant reaches very high luminance values. Fortunately, it does not extend to ground level and does not form a backdrop for traffic activities. Thus, although the surface is distracting, it is not difficult to see clearly at ground level, even when driving north on Grand Street and making a left turn onto 2<sup>nd</sup> Street. This is verified in the drive-through film. The other surfaces are not a problem.

### **Drive-Through Filming**

In order to further determine which surfaces and angles would be critical to traffic safety, a short drive-through film was taken at the worst times for each of the intersections. All of the approaches to the building were filmed. Whenever there was a turn that passed a crosswalk while facing the building, the process of making the turn was filmed. Whenever there was a left turn in the face of opposing traffic, it was filmed.

### **Key Frames**

The videos were digitized. Several key frames have been used throughout this report.

### **Traffic Density**

The number of pedestrians and vehicles throughout the day was recorded for typical weekdays. Pedestrian and vehicular traffic is variable due to the concert schedule, but because of the downtown location, the predominant traffic is not just related to activities at the Disney Hall, and the variance is likely to be minor. The traffic density certainly appears to warrant the necessary steps to ameliorate any glare, as opposed to attempting to close particular crosswalks, etc.

If crosswalks were to be closed, the primary candidates would be the crosswalk on 2<sup>nd</sup> Street in front of the CalArts Theater Marquee and the crosswalk on 1<sup>st</sup> Street, directly in front of the Founder's Room. There is no easy replacement route for the crosswalk on 2<sup>nd</sup> Street.

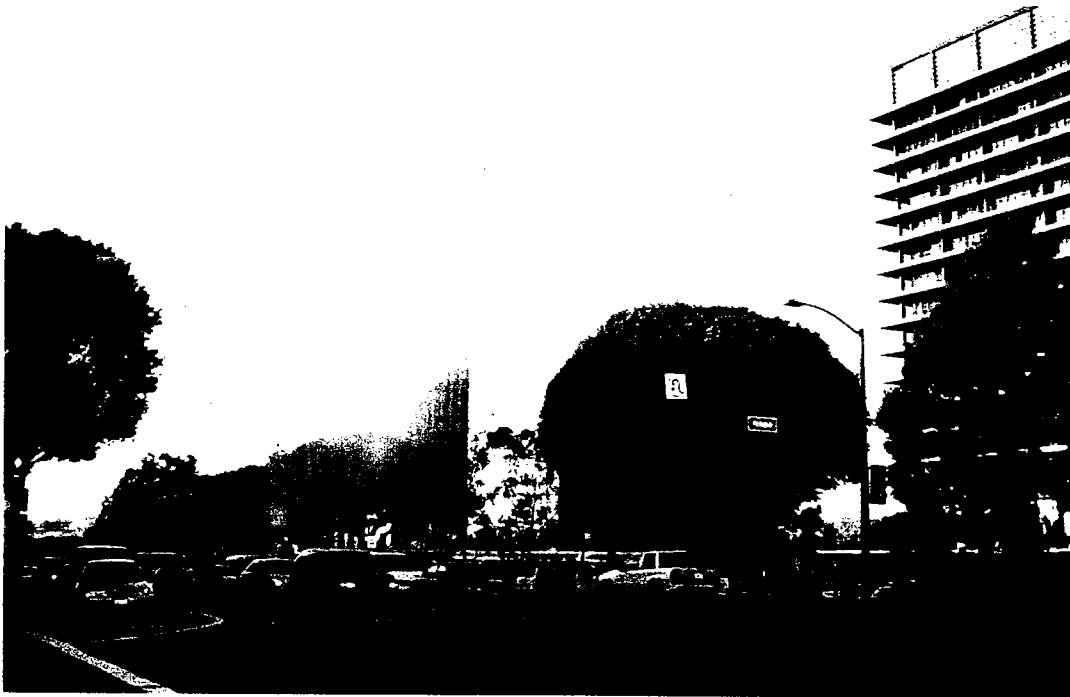
### **Results**

The drive-throughs confirm the simulations in terms of the surfaces that need to be treated and the surfaces that are bright but not dangerous. The traffic density encourages treatment of the surfaces as opposed to closure of the crosswalks, although this remains a possibility. Note that closing the crosswalks neither solves the Promenade Towers problem nor decreases the heat gain issues in front of the marquee.

### **Comparative Downtown Glare**

All buildings impact their environment and nearly all buildings increase the temperature of the surrounding surfaces. This effect has been known and studied since the early

1930s. The net effect of this phenomenon is called the “heat island” effect. In addition, the visual impact of the Disney Hall is typical of more recent buildings, built since the advent of highly reflective building materials. The Disney Hall is not unusual in contributing to this effect.

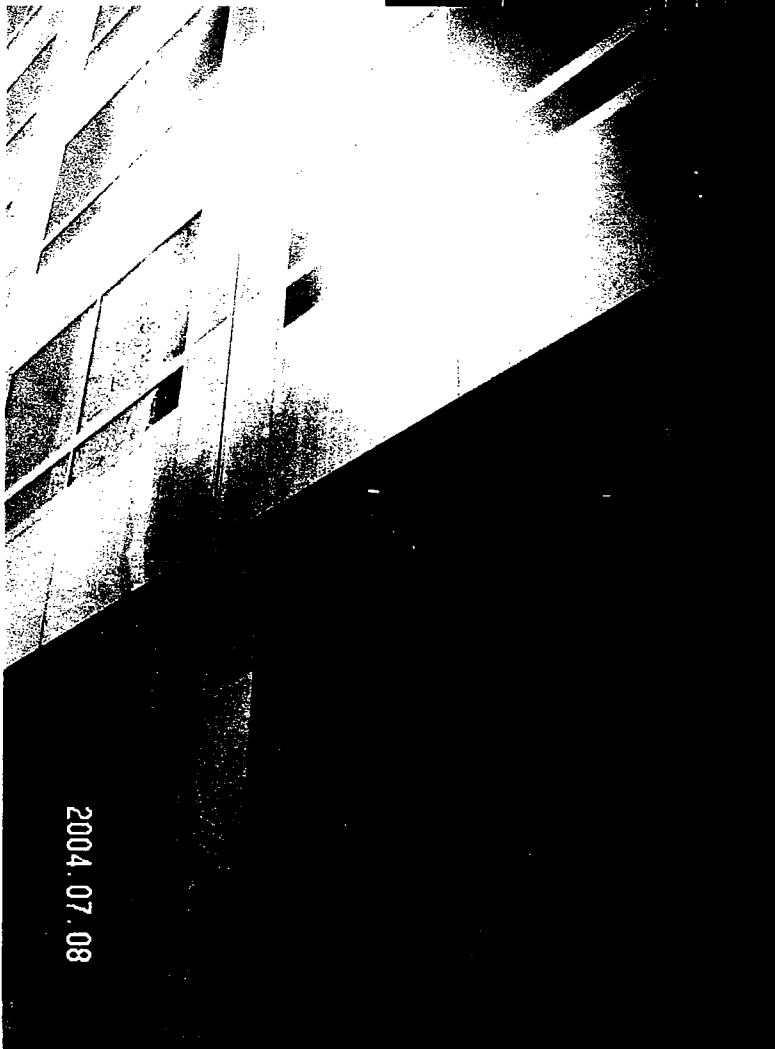
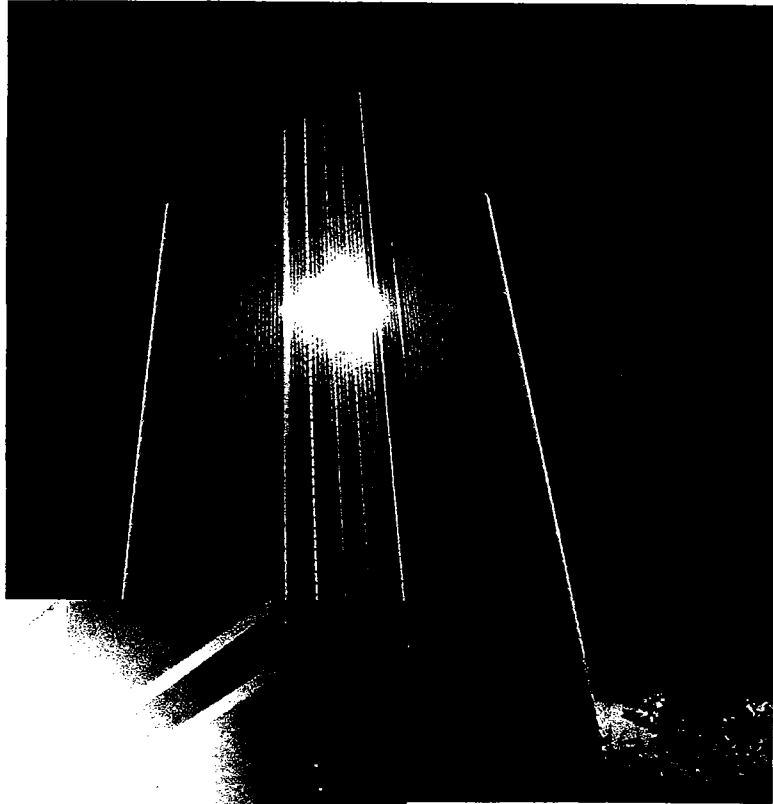


*Glare on Promenade Towers and Intersection of Hope and 1<sup>st</sup> Streets from Older Buildings*

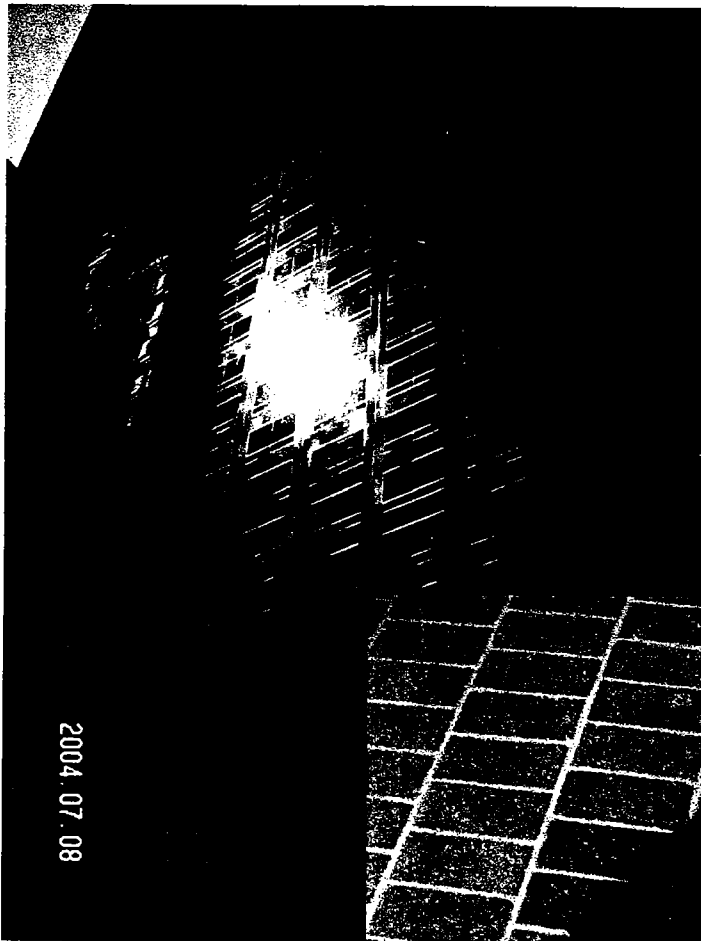
### **Downtown Buildings**

The Disney Hall is, however, an unusual building. In some instances, the impact is greater than other buildings, especially since some of the specular surfaces are curved. But in many cases, the impact is actually smaller, especially when compared to other large urban buildings.

*California Plaza –  
350 South Grand Avenue*



*Wells Fargo Center –  
333 South Grand Avenue*

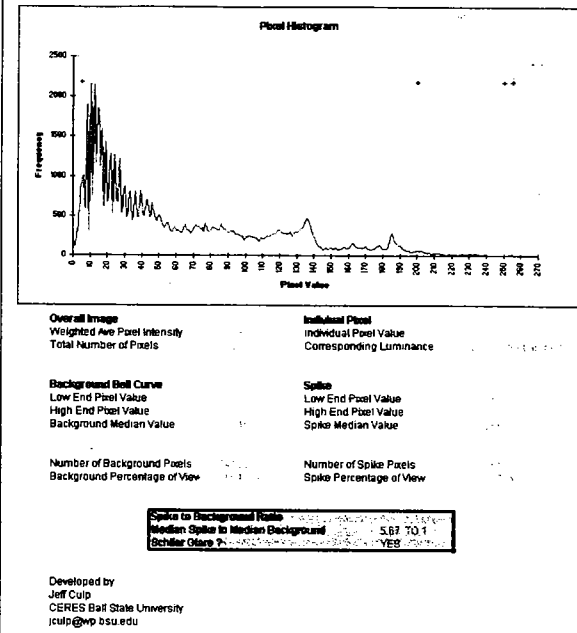


*Mellon Bank –  
400 South Hope Street*

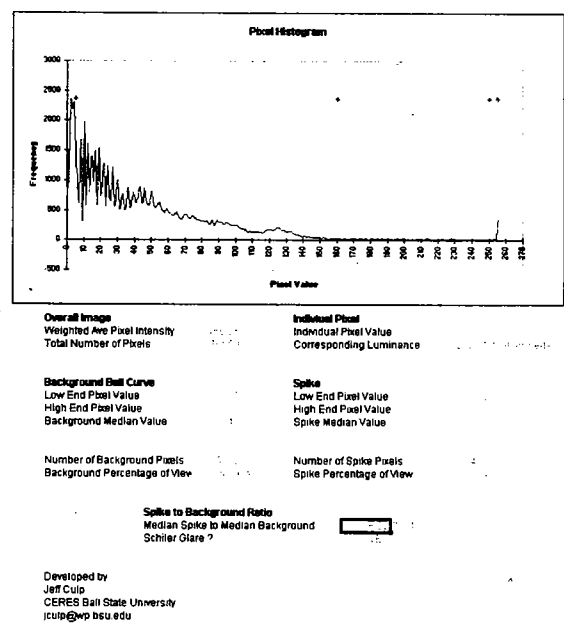
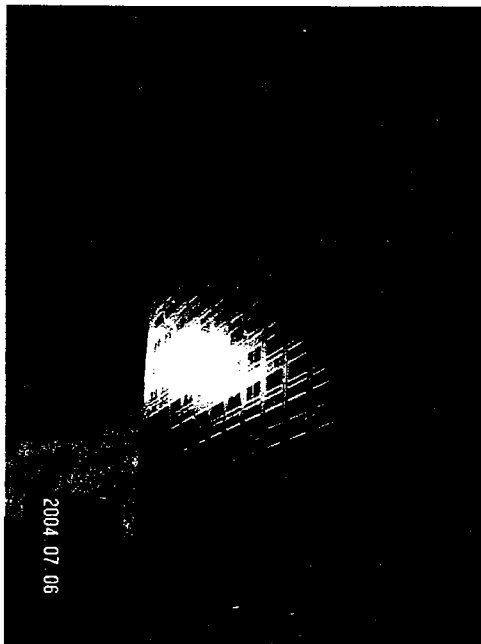
*Shadow cast by reflected  
glare, not by sunlight*



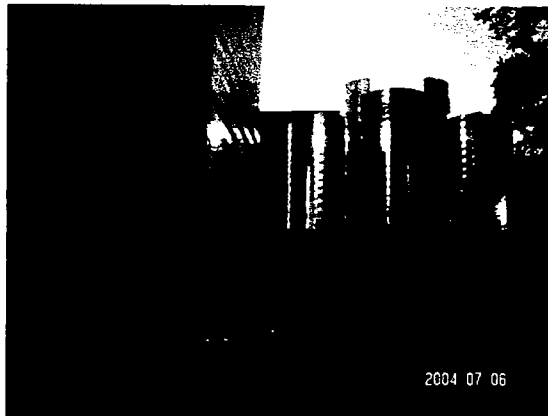
It is possible to produce a histogram of these buildings to examine the level of glare.



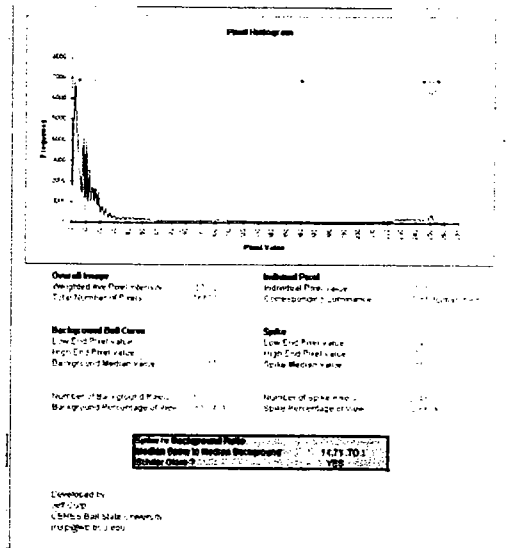
*Deutsche Bank at the California Plaza, yields a glare ratio of 5.67, even with a tree.*



*Charles Schwab at the Wells Fargo Center, 355 South Grand Avenue, yields a glare ratio of 6.62.*



*Bonaventure throwing secondary glare, yielding a glare ratio of 14.71*



## Histograms of Downtown Buildings

It is useful to examine some of the other buildings and apply the same techniques used in analyzing the images of the Disney Hall. The histograms of the downtown environment shown above can be compared with the Disney Hall histograms. Please note that they register glare **significantly in excess** of the brushed stainless steel surfaces and all but the worst of the polished (specular) surfaces on the Disney Hall.

The glare ratios for the brushed stainless steel surfaces on the Disney Hall were mostly below 2.25 and occasionally as high as 3.5. The examples of downtown glare shown above range up to a peak of 14.23 (from the Bonaventure), and values between 4.0 and 6.5 occur every day from 4:00 pm to 6:30 pm (summer sun angles) throughout the Bunker Hill / Grand Ave area.

## Other Reflective Sources in the Downtown Environment

It is even possible to consider other objects in the normal environment, such as the vehicles that navigate the same intersections. Their impact is often greater than the sources that remain stationary.



## Results

Modern building materials are often glass, metal, or polished stone. This is true for aesthetics and durability. The setback is that they are often very reflective. The reflective glass in several of the downtown buildings is as bright as or even brighter than the Disney Hall.

The Disney Hall uses four general categories of materials: stone/concrete, glass, polished stainless steel, and brushed stainless steel. All of these materials are used in other buildings in the downtown area. The only difference is that, in the Disney Hall, most of the facades are curved. Most of those facades are brushed stainless steel, which means that they reflect and reradiate heat but do not focus it; however, most of the buildings in downtown do focus heat. The only unusual surfaces are the concave polished reflecting surfaces. Most of those focus on thin air. There are only a few surface that beam light into occupied areas, and those can be defocused by simple treatment.

## Luminance Histograms

Glare is in the eye of the beholder, literally. Most measures of glare are qualitative. At least one measure of glare, Visual Comfort Probability (VCP), attempts to calculate what percentage of the occupants of a space will conclude that there is glare present. Unfortunately, the method was developed for interior spaces and uniform arrangements of fluorescent fixtures and is not easily applied to exterior and extremely varied environments.

Glare is in the world around us at all times. There is glare on the Promenade Towers from other buildings. Indeed, all of us experience glare all the time. There is glare from cars that pass by on a sunny day and from parking lots full of cars. There are far worse instances of glare throughout the City. The sun itself is by far the brightest source of glare. The sun, however, is mostly overhead and thus can be dealt with using overhangs, fins, and awnings. For low sun angles, or when overhangs are not present, curtains, shades, blinds, and other devices can be manipulated and adjusted throughout the day to decrease or remove glare.

At least three levels of glare are generally recognized and a fourth is inferred by default. **Veiling reflections** refer to glare that is objectionable primarily because it covers up desired information. Reflections on a glossy magazine are one example. **Discomfort glare** is glare that viewers find objectionable, but it does not do any damage. **Disability glare** ranges from causing temporary incapacity to causing damage to the eye. These three levels, by default, define the level of glare noticed by people but considered part of

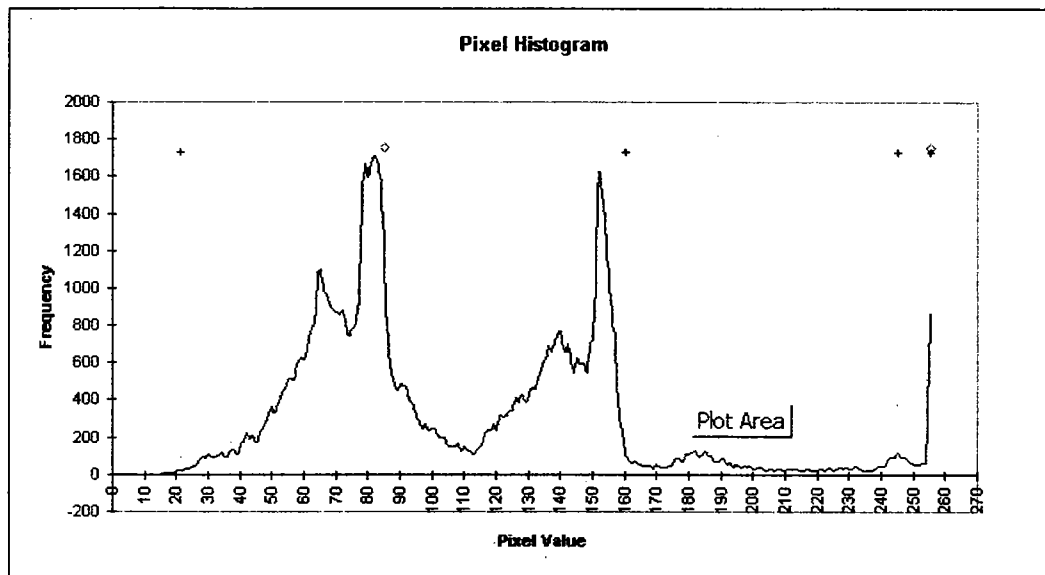
the normal environment. Indeed, phenomena characterized as positive or even delightful come from extreme contrasts, such as sparkle or brilliance. These depend heavily on context, of course.

One of the ways of analyzing possible glare sources in exterior environments is by creating a luminance histogram of the comparative “brightness” or luminance within a scene. With this we can study contrasts. The author of this report has published research papers on this method over the past eight years. There has been significant discussion of this and similar methods. Ball State University has written software that uses these methods to translate visual images into raw data files and analyze them automatically, using MS-Excel statistical and graphing functions. Similar functions are available in Adobe Photoshop.

The surfaces found to be possible glare sources in the preceding simulations are examined using histograms of the critical images (worst hours) to determine whether the glare achieves serious levels. The Schiler glare method considers an image to have glare when the possible glare source is more than three times the median of the background curve. This would correspond to discomfort glare. Other methods (Lawrence Berkeley Lab/Gregg Ward) do not consider the image to be a source of glare until the possible glare source is eight times the median of the entire image. This is a much less sensitive standard.

### Histogram of Founder's Room "Knee" Surface

The output page of the program, which includes the histogram and the analysis, is included in its entirety. Note that discomfort glare is clearly indicated.


**Overall Image**

Weighted Ave Pixel Intensity 125.69  
Total Number of Pixels 76800

**Individual Pixel**

Individual Pixel Value 116  
Corresponding Luminance 250.27 lumens

**Background Bell Curve**

Low End Pixel Value 21  
High End Pixel Value 160  
Background Median Value 85

**Spike**

Low End Pixel Value 245  
High End Pixel Value 255  
Spike Median Value 255

Number of Background Pixels 70926  
Background Percentage of View 92.35 %

Number of Spike Pixels 1614  
Spike Percentage of View 2.10 %

**Spike to Background Ratio**

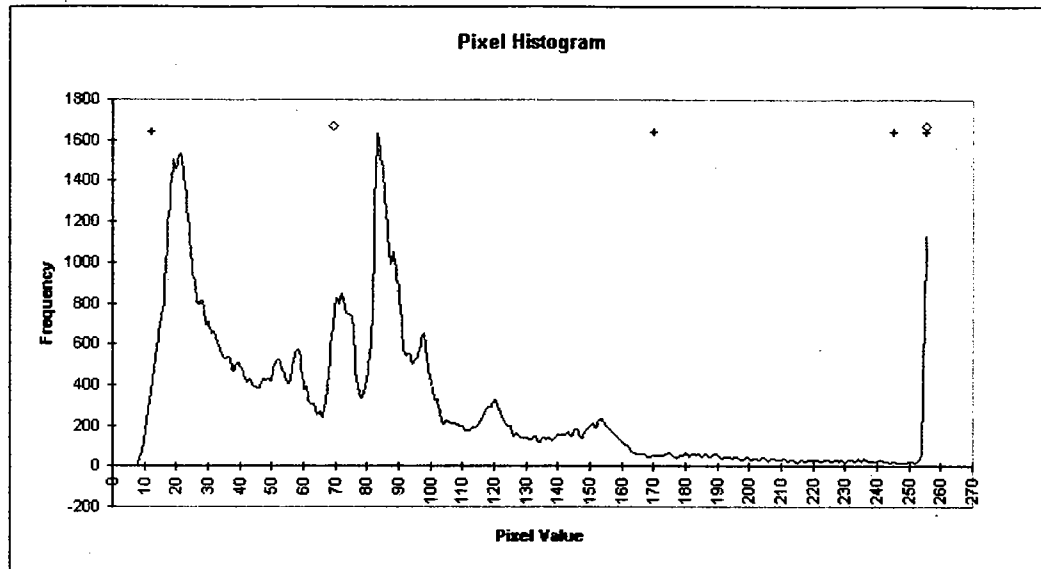
Median Spike to Median Background  
Schiler Glare ?

3.00 TO 1  
☒ YES

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### Histogram of Founder's Room "Eye" Surface

The output page of the program, which includes the histogram and the analysis, is included in its entirety. Note that discomfort glare is clearly indicated.


**Overall Image**

Weighted Ave Pixel Intensity 87.52  
Total Number of Pixels 76800

**Individual Pixel**

Individual Pixel Value 116  
Corresponding Luminance 250.27 lumens

**Background Bell Curve**

Low End Pixel Value 12  
High End Pixel Value 170  
Background Median Value 69

**Spike**

Low End Pixel Value 245  
High End Pixel Value 255  
Spike Median Value 255

Number of Background Pixels 72171  
Background Percentage of View 93.97 %

Number of Spike Pixels 1374  
Spike Percentage of View 1.79 %

**Spike to Background Ratio**

Median Spike to Median Background  
Schiler Glare ?

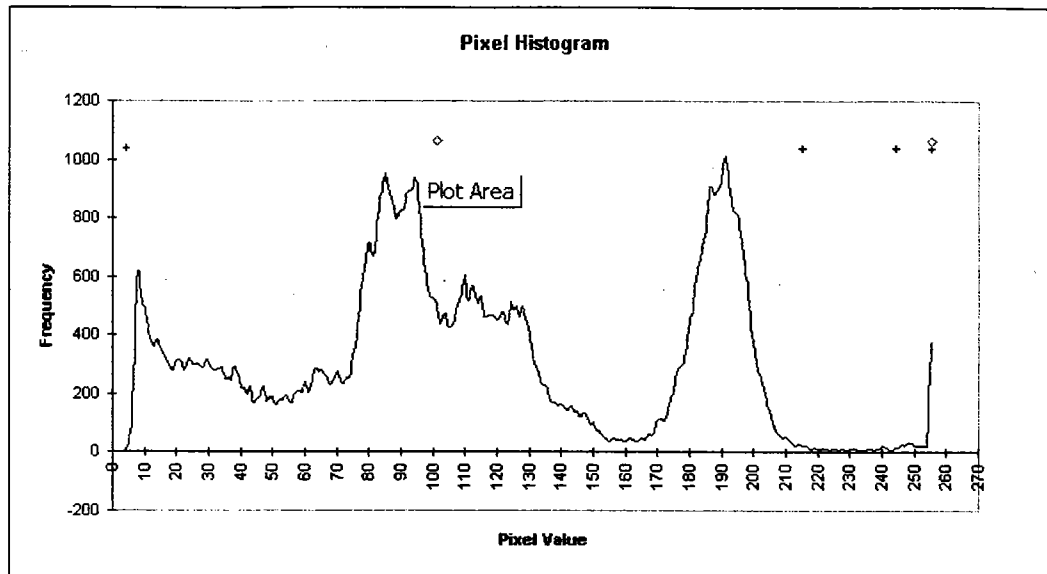
3.70 TO 1

☒ YES

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## Histogram of Hope Street Elevation

The output page of the program, which includes the histogram and the analysis, is included in its entirety. Note that glare is possible but not definite.



### Overall Image

Weighted Ave Pixel Intensity 129.92  
Total Number of Pixels 76800

### Individual Pixel

Individual Pixel Value 116  
Corresponding Luminance 250.27 lumens

### Background Bell Curve

Low End Pixel Value 4  
High End Pixel Value 215  
Background Median Value 101

### Spike

Low End Pixel Value 244  
High End Pixel Value 255  
Spike Median Value 255

Number of Background Pixels 75852  
Background Percentage of View 98.77 %

Number of Spike Pixels 636  
Spike Percentage of View 0.83 %

### Spike to Background Ratio

Median Spike to Median Background  
Schiler Glare ?

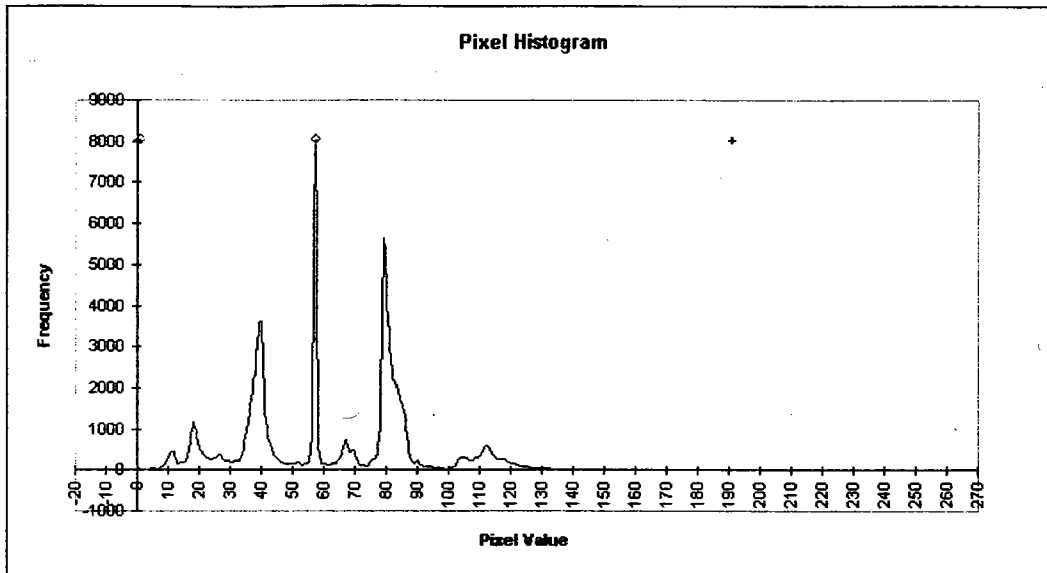
2.52 TO 1

**MAYBE**

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## Histogram of 2nd Street Elevation

The output page of the program, which includes the histogram and the analysis, is included in its entirety. Note that there is definitely no glare.


**Overall Image**

Weighted Ave Pixel Intensity 72.68  
Total Number of Pixels 76800

**Individual Pixel**

Individual Pixel Value 116  
Corresponding Luminance 250.27 lumens

**Background Bell Curve**

Low End Pixel Value 0  
High End Pixel Value 191  
Background Median Value 57

**Spike**

Low End Pixel Value 0  
High End Pixel Value 0  
Spike Median Value 1

Number of Background Pixels 76752  
Background Percentage of View 99.94 %

Number of Spike Pixels 77  
Spike Percentage of View 0.10 %

**Spike to Background Ratio**

Median Spike to Median Background  
Schiler Glare ?

0.02 TO 1

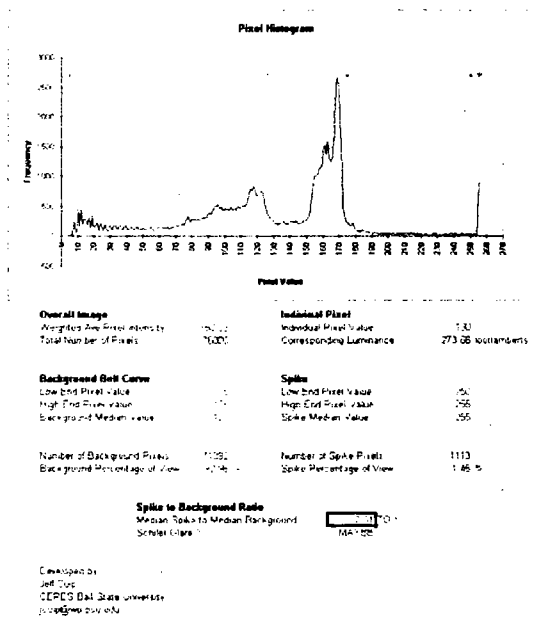
NO

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## Histogram of 1<sup>st</sup> and Grand Streets

Most of the photographs of the intersection indicate no glare in the associated histogram. Some are close, showing a “Maybe” in the glare column, with values over 2.25 but under 3.0.

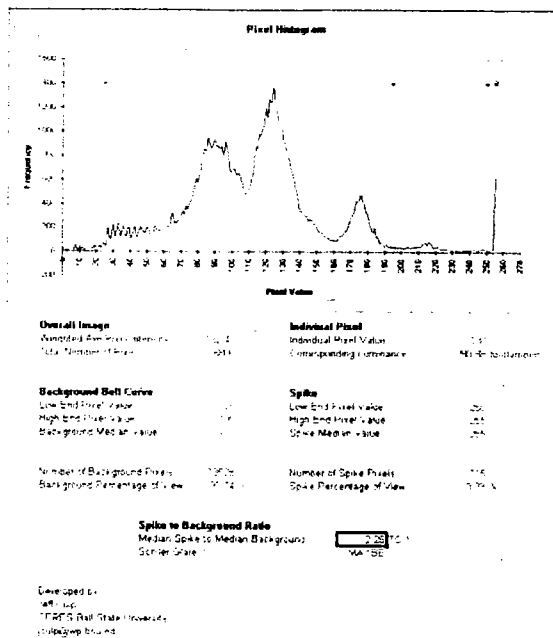
The output page of the program, which includes the histogram and the analysis, is included in its entirety. Note that discomfort glare is not indicated.



*Histogram of the intersection of 1<sup>st</sup> and Grand Streets at 11:50 a.m. on July 2.*

## Histogram of 2<sup>nd</sup> and Grand Streets

The output page of the program, which includes the histogram and the analysis, is included in its entirety. Note that discomfort glare is clearly indicated.

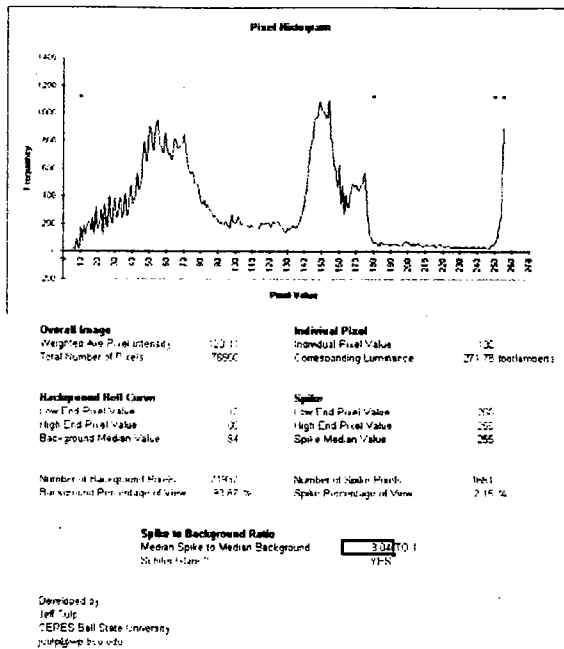


*Histogram of the Intersection of 2<sup>nd</sup> and Grand Streets at 1:20 p.m. on June 23*



## Histogram of 2<sup>nd</sup> and Hope Streets

The output page of the program, which includes the histogram and the analysis, is included in its entirety. Note that discomfort glare is clearly indicated.



*Histogram of the Intersection of 2<sup>nd</sup> and Hope Streets at 7:15 p.m. on June 23*

## Histograms of other Downtown Buildings

The histograms of some of the other photographs of downtown buildings are presented in the Comparative Glare section. The same procedure was used on those photographs as was used on the Disney Hall photographs.

## Summary

None of the plots achieve levels of certain *disability* glare. The Founder's Room surfaces clearly indicate *discomfort* glare. Even the brushed surface on the Hope Street elevation indicates the possibility of glare by the Schiler method, although it would fall below the glare threshold according to the LBL/Ward method. The 2<sup>nd</sup> Street elevation causes no glare.

## **Solutions**

As indicated above, the polished stainless steel surfaces of the Founder's Room and CalArts Theater Marquee clearly require some remediation. The surfaces requiring treatment are indicated in red in their respective simulations, as well as being visible in their respective photographs.

Several interim and final solutions were considered. One of the solutions included superposing a film over the critical surfaces. The reflectance of the original surface was studied, and the surface was modified by four different films: (1) a colorless, translucent, and slightly diffusing film; (2) a light blue, translucent, and diffusing film; (3) a white and more strongly diffusing film; and (4) a white and opaque film with a black backing.

### **Colorless Translucent Film**

The colorless translucent film reduces the reflectance only slightly (~2.5 percent) and hardly diffuses the specular focusing, making it an insufficient change. The "eye" surface is too close to its secondary reflectors and the beam would likely remain collimated. The lower surfaces would benefit, but there would still be significant reflection.

### **Light Blue Translucent Film**

The light blue translucent film reduces the reflectance more substantially (~10 percent). More importantly, the diffusion is significant, which should result in a defocusing of the collimated beam.

Although it would be preferable to have a gray film for the sake of visual and architectural consistency, the blue coloring has a secondary benefit. Sunlight is somewhat red-shifted (lower °K) from skylight (higher °K). The blue film absorbs more sunlight (direct beam) and less skylight (diffuse ambient). This means that the focused reflection is reduced more than the general reflection, making the change more specific to possible glare than of less impact on the general image of the building.

### **White Translucent Film**

The white translucent film reduces the transmissivity slightly (~7 percent) but completely defocuses any specular reflection. This is actually the safest solution.

Unfortunately, the visual impact and the change in the architectural statement of the surface would be very significant. This is the correct solution if *only glare* is being considered.

### **White Opaque Film**

The solid white opaque film reduces the reflectance significantly (~15 percent) but creates a new specular surface, which would not defocus the collimated beam.

The visual impact would be equal to the white translucent film, but the film would still cause focusing and collimation, possibly resulting in a situation very similar to the original situation.

### **Test Panel**

A test panel was constructed with all five conditions (original polished surface, colorless film, blue film, white translucent film, and white opaque film.) An image was projected onto the panel and reflected onto a matte white surface. The diffusion was recorded. The blue and the two white films were adequate.

The panel was then placed on the Founder's Room on one of the lower surfaces under varying sun conditions. The reflection was targeted onto a white matte surface. The sun spot was clear from the original surface, only vaguely diffused by the colorless film, almost completely diffused by the blue film, and completely diffused (e.g., scattered) by both of the white films.

### **Outdoor Fabric**

A textile sample was provided by the architect and tested in the same manner as the films described above. The solid fabric mesh reduces the reflectance significantly and completely diffuses the direct beam radiation with surprisingly little difference in the overall perception of the building.

The fabric was implemented as a temporary solution as was suitable to the extent that it covered the reflective surfaces. The portions of the reflective surfaces that were not covered still resulted in some glare.

### **Sandblasted Surface**

A sandblasted surface was provided by the architect and tested in the same manner as the films described above. The sandblasted surface reduces the reflectance significantly and produces a visual effect similar to the brushed stainless steel panels on the rest of the building. The surface treatment would be much more durable than the fabric, although perhaps slightly less effective.

The visual impact would be equal to the rest of the building, reducing the focusing effect of the surfaces and diffusing the direct beam glare. This treatment could be combined in a creative manner with other similar treatments on the CalArts Theater Marquee. The offending surfaces on the Founder's Room could be completely covered or covered in conjunction with some other treatment method, depending on the aesthetic intention of the architect.

### **Temperatures at CalArts Theater Marquee on Sidewalk and Street**

There have been reports of reflections and increased temperatures in the immediate vicinity of the CalArts Theater Marquee. Again, there is no doubt that there is a certain increase in sparkle and excitement created by the marquee. There is some question, however, of whether the increased radiant gain in the neighborhood of the marquee might cause some difficulty.

This report examines the instances of possible heat gain, the level of such heat gain, and what amelioration might prove useful. The possibility of traffic glare was considered in a previous section of this report.

### **Temperature and Radiant Heat**

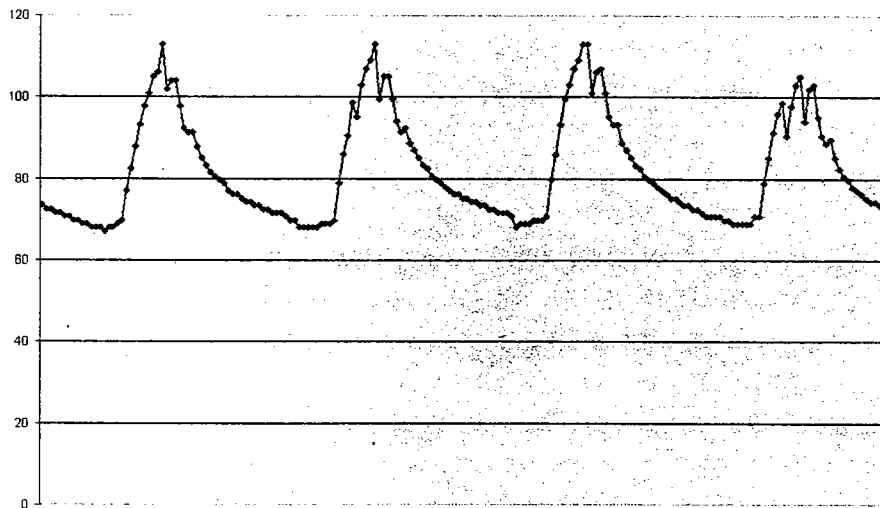
An inspection of the site clearly indicated some radiant gain. It was possible to determine whether or not an observer was standing in the reflected beam from the marquee simply by walking along the street with one's eyes closed. One could feel the radiant heat as one passed through the beam. The real question was, "What are the resulting temperatures attained on the receiving surfaces?" During the installation of the

temperature loggers in the summer testing (below), there was significant discomfort if one held one's hand in the beam for more than a minute.

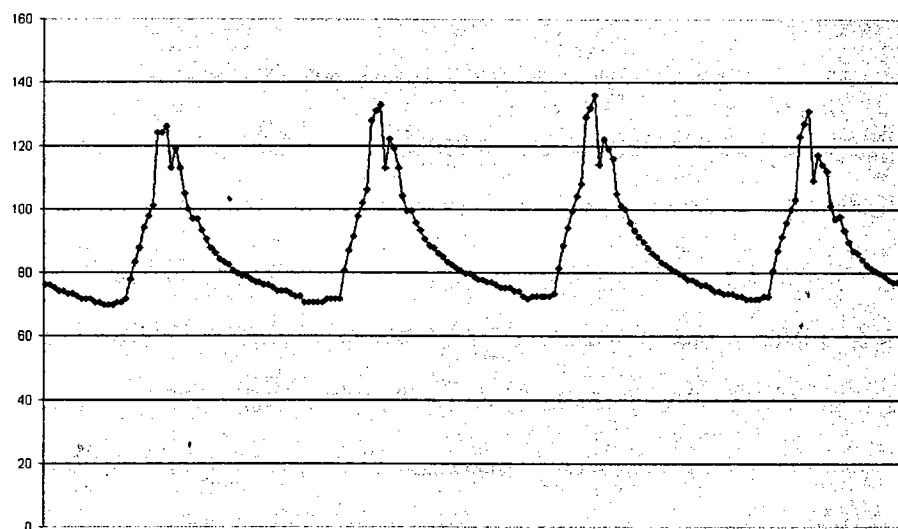
To determine the range of temperatures, dataloggers were embedded in the ground in front of the marquee. In March (the equinox) they were embedded in the street surface in a row across the front of the CalArts Theater entrance, in front of the marquee, where the concrete curb pieces met the street asphalt. An additional datalogger was embedded in the street at a visible focus point.

There was a typical pattern to the data. Sunrise was clearly visible as the sidewalk began to heat up. There was a dip shortly after the peak, followed by a steady fade as the sidewalk cooled.

Typical Curb Surface (F) - Sunday - Wednesday



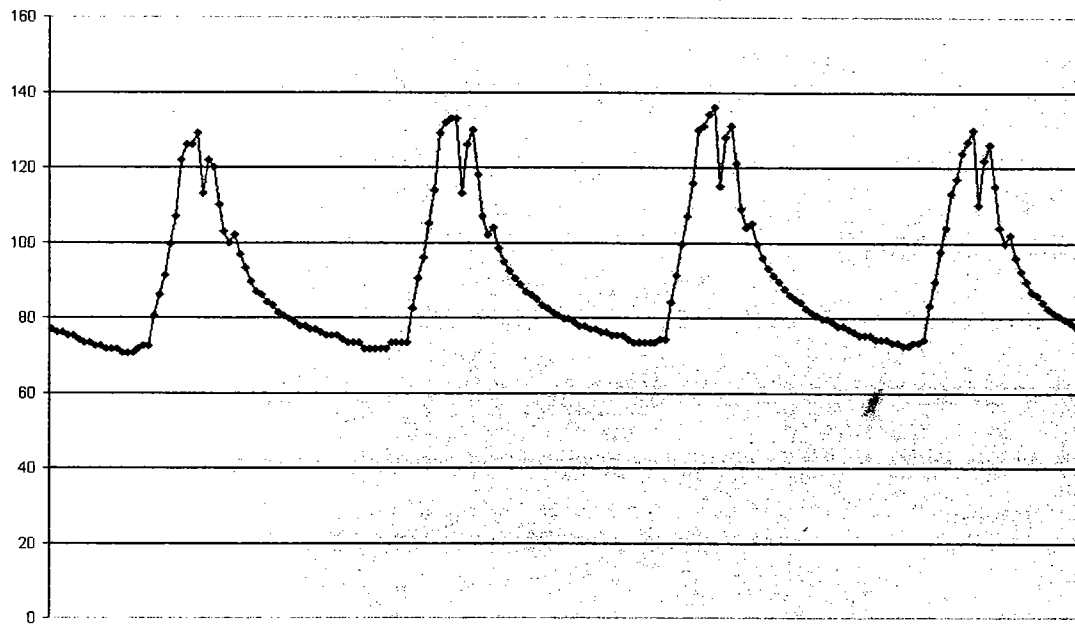
Curb Pos 5 (F), Sunday - Wednesday



### Equinox Temperatures

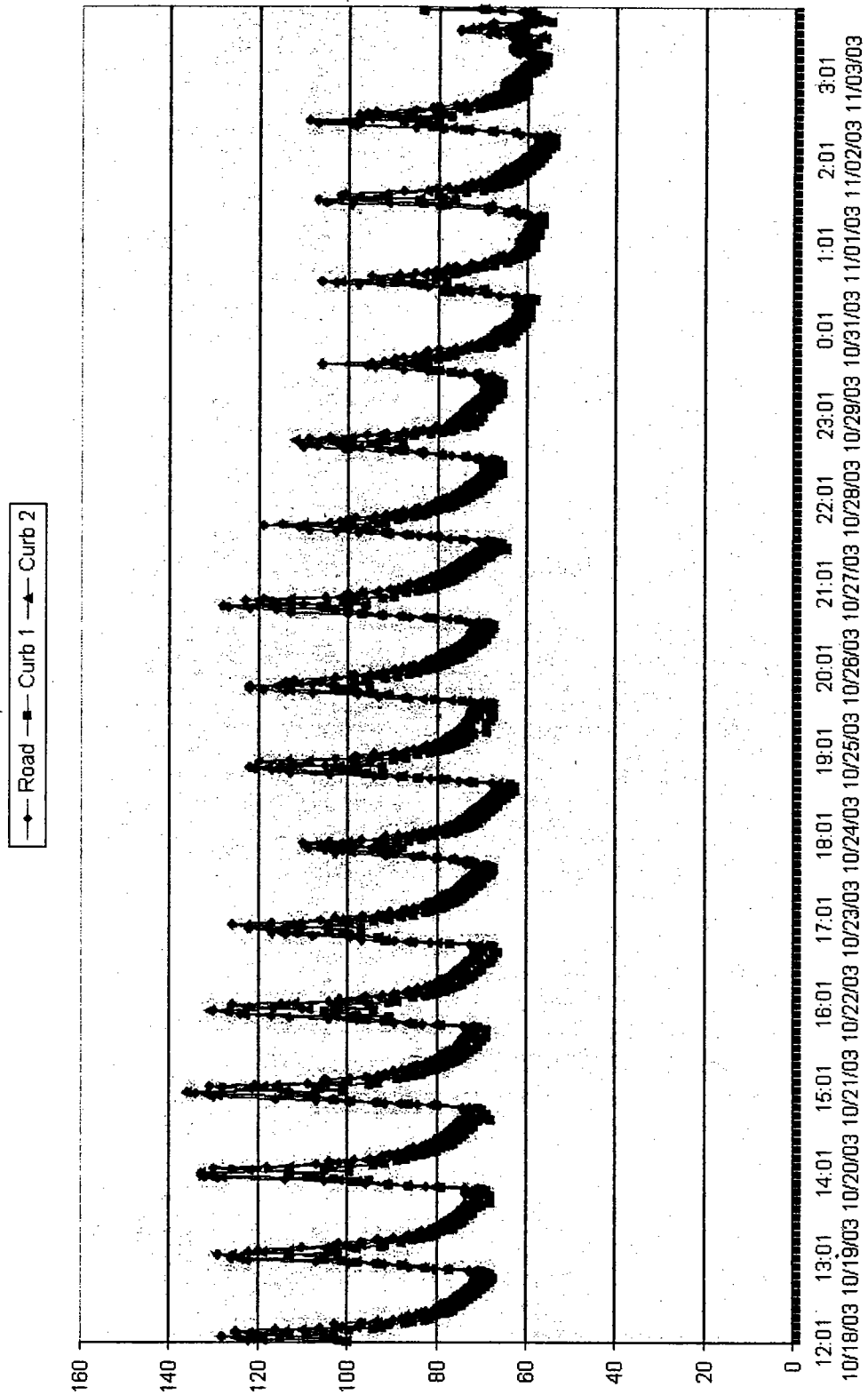
The typical maximum temperature peaks at about 125 degrees Fahrenheit (°F). The maximum temperature at one of the curb edge locations and in the roadbed focal point peaks at about 138°F. Although elevated, such temperatures are not dangerous to people unless there is prolonged exposure. Such temperatures do not cause spontaneous combustion of paper materials, which requires over 400°F.

Road Surface (F), Sunday - Wednesday



It is interesting to note that on all of the sensors, just before the expected peak temperatures occur, there is a sudden dip. Such a dip would be explained by a massive shadow covering the entire marquee. Inspection of the site confirms that 333 South Grand Street (currently the Wells Fargo Bank building) shades the marquee at that time of day, during winter months. This indicates that summer months (with higher sun angles and higher ambient air temperatures) will achieve higher surface temperatures. It would be useful to repeat the test in July when the marquee is not shaded by the Wells Fargo or the BP (formerly Interstate Bank) Building.

A review of all two weeks of the data shows the same general behavior.

**Surface Temperatures (F) - Two Weeks**

### Summer Temperatures



The patterns were the same as the spring temperatures, except that the days became progressively longer, before cooling off.

The typical maximum temperature peaks at about 140°F. This is surprisingly close to the spring values, indicating that the radiant heat is the dominant factor and the air temperature is a secondary consideration, especially on ground surfaces. Although elevated, such temperatures are not dangerous to people unless there is prolonged exposure. Stationary exposure to a direct focus (>10 minutes), however, would result in the equivalent of a bad sunburn. A lightweight material (e.g., dark plastic) would achieve higher temperatures than those recorded.

Such temperatures do not cause spontaneous combustion of paper materials, which usually requires over 400°F. It is possible that temperatures sufficient to melt plastic would be achieved in the focal points. Indeed, certain materials prone to spontaneous combustion might ignite under the right conditions. Plastic bottles in the concentrated beam could further focus the beam, creating even higher temperatures. This is another strong indication that the marquee should be treated to defocus the beams.



## **Conclusions**

### **Temporary Solution**

If there is any significant delay in applying a permanent solution, the gray fabric should be placed on the surfaces of the Founder's Room currently causing focused reflection onto the Promenade Towers and onto the intersection of 1<sup>st</sup> and Hope streets.

### **Permanent Solution**

Several permanent solutions should be considered. It would be useful to sandblast the critical polished surfaces, apply a permanent film, or deposit a frit on them. It is also important that the trees on site be maintained in full foliage. They form a part of the solution. Any loss of leaf or reduction in size or density would result in an increase in glare. Again, all of the surfaces on the Founder's Room and the CalArts Theater Marquee should be treated in the manner indicated in the respective segments.

### **Further Studies**

No further studies are currently recommended. The dataloggers placed in front of the CalArts Theater Marquee will be left in place long enough to get data from warmer weather. That data will be available to the County or Sapphos Environmental, Inc., upon request.

## **Summary**

Disney Hall is a scintillating building in every sense of the word. It presents some difficulties with glare. However, the difficulties discovered thus far fall into two categories. There is some glare that is visible but not critical. There is some glare that may be critical but can be resolved by following the recommendations indicated above.

